MOTIVATING CHILDREN WITH AUTISM TO RIDE A STATIONARY RECUMBENT BICYCLE USING CONTINGENT AND DELAYED REINFORCEMENT

by

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STATEMENT OF DISSERTATION APPROVAL

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ABSTRACT

There are an increasing number of individuals being diagnosed with autism. The CDC reports that 1 in every 110 children has been diagnosed with some form of autism. With this increase, there are more and more children with autism participating in general physical education classes. Furthermore, research has indicated that children with autism are as likely to become obese as children who do not have autism. The purpose of this study was to see if children with autism would pedal a stationary recumbent bicycle for a greater duration of time using contingent reinforcement versus delayed reinforcement.

Nine students from the Carmen B. Pingree Center for Children with Autism were recruited for this study. They were randomly selected to the order of treatment either contingent reinforcement or delayed reinforcement. In the contingent reinforcement phase, when the participant pedaled in his/her target heart rate zone (THRZ), the television would turn on and would remain on as long as they stayed in their THRZ. In a delayed reinforcement phase, the participant was told they could watch television after they pedaled in their THRZ.

The split-middle technique was used to analyze and compare trends in and across both the contingent reinforcement phase and delayed reinforcement phase.

Results indicated that there was a positive trend to increase pedal duration during the contingent phase in 7 of the 9 participants compared to only 2 of the 9 showing a positive trend to increase pedal duration during the delayed reinforcement phase. This

indicated that the 7 participants would increase their physical activity by pedaling for a longer time over the duration of the contingent phase compared to only 2 participants increasing their pedal duration in the delayed reinforcement phase. Differences between the contingent reinforcement phase and the delayed reinforcement phase were found to be statistically significant in 7 of the 9 participants. In addition, the total time pedaled was higher in the contingent reinforcement phase compared to the delayed reinforcement phase with 8 of the 9 participants. The overall findings indicated that contingent reinforcement showed a trend to increase pedal time in their THRZ compared to the trend of pedaling in their THRZ in the delayed reinforcement phase.

I would like to dedicate this dissertation to my beautiful wife; without her endurance, this would not have been possible; also to my children, my Mother, and my Father.

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CHAPTER 1

INTRODUCTION

Pervasive Developmental Disorder (PDD) and Autism Spectrum Disorder (ASD) are umbrella terms that have been introduced in the past three decades (Jordan, 2005; Zaretsky, Richter, & Eisenberg, 2005) to classify several developmental disorders. These disorders are characterized by communication, social, and behavior deficits in children (Merrick, Kandel, & Morad, 2004). In 1943, Leo Kanner coined the term "autism" for the developmental disorder that consists of markedly abnormal development in social interaction and communication skills accompanied by abnormal behaviors and interests. A year later, Hans Asperger observed several children with similar characteristics as classic autism such as impairment in social interaction and the presence of restricted, repetitive patterns of behaviors, interests, and activities; however, the children he observed were higher functioning and had sufficient verbal skills. This disorder he called Asperger's syndrome (AS). Unlike the autism that Leo Kanner first observed, the majority of cases of AS have average intellectual ability and usually no delays in language acquisition. Since then, other developmental disorders such as Rett's syndrome, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS) have been categorized under the umbrella terms of PDD/ASD (American Psychiatric Association, 2000).

Interest in autism among researchers has increased rapidly over the years. This is due to the fact that the prevalence of autism in children has increased significantly in the past several years. For example, before 1985, the prevalence of autism in some studies was as little as 4 to 5 individuals diagnosed with autism out of 10,000 (Yeargin-Allsop et al., 2003). Today, there is approximately 1 case diagnosed in every 110 children nationally as having some form of an ASD with 1 in every 70 boys and 1 in 315 girls reporting characteristics (Centers for Disease Control, 2010a). Given these recent prevalence figures, approximately 91 out of 10,000 are diagnosed as having some form of autism; a 22-fold increase in the last 25 years. Possible explanations for this increase in prevalence of autism are the fact that we now have better diagnostic techniques with which to identify autism (Baird, Cass, & Slonims, 2004; Keen, & Ward, 2004) and more cases with mild symptoms are being identified (CDC, 2010a).

Autism has been categorized primarily as a communication and social disorder (Baird et al., 2004; CDC, 2007). However, other characteristics have been known to accompany the aforementioned symptoms such as abnormal sleep patterns (Honomichi, Goodlin-Jones, Burnham, Gaylor, & Anders, 2002) and deficits in play patterns (Rutherford, & Rogers, 2003) along with behaviors that are abnormal such as adherence to specific routines, repetitive motions such as hand flapping, and preoccupation with certain objects or parts of an object (American Psychiatric Association, 2000). Children with autism may also show signs of intellectual disabilities (Shea & Mesibov, 2005). A report by the CDC examined children with autism in six states and found that approximately 41% of individuals with autism in the 2006 study also showed signs of "cognitive impairment" (CDC, 2010a).

It has been reported by the Centers for Disease Control that over the years, obesity has increased among adolescents in the general population. As a consequence the general adolescent population has become more at risk for certain obesity-related illnesses at a younger age (Gascon et al., 2004; Gaylor, & Condren, 2004; Gordon-Larsen, Adair, Nelson, & Popkin, 2004; Hesketh, Wake, & Waters, 2004; Kiess et al., 2001; Paradis et al., 2004; Williams, Strobino, Bollella, & Brotanek, 2004). The CDC has reported that individuals with disabilities tend to be less physically active and consequently, they are more obese than individuals who are not disabled (CDC, 2007). Recent research has shown that children with ASD are showing a trend similar to the general population of an increase in obesity due to limited physical activity (Curtin, Bandini, Perrin, Tybor, & Must, 2005).

An increase in physical activity may not only benefit the health of children with autism but there is limited research to suggest that there may be a decrease in inappropriate behaviors, such as self-stimulation, following a bout of physical activity (Celiberti, Bobo, Kelly, & Handleman, 1997; Elliot, Dobbin, Rose, & Soper, 1994; Rosenthal-Malek & Mitchell, 1997). The earlier an intervention can be introduced into the child's life, the greater the success of improving the child's unwanted behaviors (CDC, 2010a; Woods & Wetherby, 2003).

O. Ivar Lovaas, a renowned researcher with children with autism, has shown that behavioral treatments have been successful in this population to increase speaking ability as well as eliminate self-stimulation (Lovaas, 1993; Pierce & Cheney, 2004). Lovaas (1981) suggested that a reward system as well as punishment can be used to help change behaviors. The approach that currently shows the greatest amount of success with respect to behavior modification in children diagnosed with autism is Applied Behavior Analysis (ABA). This behavioral approach in learning theory provides reinforcement as a consequence when the desired behavior is observed in order to increase the future occurrence of that behavior. When an undesirable behavior is observed, punishment is provided to decrease the future occurrence of that behavior (Lavay, French, & Henderson, 2006).

From 1974 to the present day, there have only been 18 research publications that examined physical activity and individuals with autism (Lang et al., 2010). Only one of those studies examined how different interventions would increase physical activity in this population. Researchers observed 3 male secondary students who were diagnosed as having autism. Each participated in snowshoeing and walking/jogging activities over a 6-month period. The participants received edible reinforcers along with verbal encouragement. The researchers found that each participant increased physical activity in the two exercise conditions when edible reinforcers were used (Todd & Reid, 2006).

According to Roemmich, Gurgol, and Epstein (2003), feedback can be administered in one of two ways, as either open or closed-loop feedback. Open-loop feedback is presented after the entire task is complete. This may also be referred to as delayed reinforcement. For example, when the participant completes a task such as riding a bicycle for a specified time, the participant is then rewarded with something that has value to them. It is usually administered through human interaction. Closed-loop feedback is given immediately when an output goal from the individual is reached while performing a task. This is also referred to as contingent reinforcement. An illustration of this is controlling television viewing contingent upon pedaling a bicycle.

Purpose Statement

Research to determine how children that are diagnosed with some form of ASD can be motivated to develop a more physically active lifestyle to promote health and decrease unwanted behaviors is scarce. According to recent literature, there is a trend among children with autism to become more obese (Curtin et al., 2005). A major concern is developing a means to motivate children to become more physically active. This has become a challenge not only for the general population but also for children who have autism. The primary purpose of this research was to determine whether contingent reinforcement using a recumbent stationary cycle and a television monitor, which is turned on by reaching a predetermined THRZ, will motivate children with autism to pedal the cycle in their THRZ for a longer duration than delayed reinforcement.

Providing teachers and parents with the option of television viewing, which is contingent on pedaling a bicycle, may help motivate children with autism to increase their physical activity. Health risks related to inactivity can be decreased, motor skills can be improved, fitness levels can be increased, and children can gain confidence to participate in physical and sporting activities.

Primary Aim

The primary aim of this research project was to determine whether the trend for pedaling longer in the THRZ on a stationary recumbent cycle would be greater when contingent reinforcement was administered than when delayed reinforcement was administered.

Primary Hypothesis

It was hypothesized that using contingent reinforcement in the form of conditional television viewing tied to pedaling a recumbent stationary cycle within an individual's THRZ would increase the trend of pedaling more than using delayed reinforcement with individuals with autism.

Delimitations

The study was delimited as follows:

1. The participants were students from Carmen B. Pingree Center for Children with Autism.
2. Participants who were recruited to participate in the study were limited to the ages of 6 and 12 years old due to the fact that the majority of the children in this center were in that age range.

Limitations

The following limitations may have impacted the outcome of this study:

1. Teachers chose higher functioning children from their classes. This may restrict the ability to generalize these results to lower functioning children with autism.
2. A small sample size was utilized.
3. Heart rate formulas that utilize age to calculate maximum heart rate do not have a linear relationship in children and may overestimate maximum heart rate (Gilbert, 2005; Hui & Chan, 2006). However, no formulas that eliminate age as a factor are suggested in other research, but on the contrary, age is used to predict maximum heart rate (Ridgers, & Stratton, 2005; Scruggs, Beveridge, & Clocksin,

2005; Scruggs, Beveridge & Watson, 2003; Stratton, 2000; Stratton, Ridgers, Fairclough, & Richardson, 2007).

4. Autism Spectrum Disorder (ASD) is a varied disability that is unique to each individual.
5. For some of the participants, verbal expression was limited, thus creating a communication barrier.

Assumptions

During this research, the following assumptions were made:

1. Heart rate reserve (HRR) is an appropriate method for calculating target heart rate zone (THRZ) in children (Stratton, 1996)
2. Television viewing has some intrinsic value for participants in this research study.

CHAPTER 2

REVIEW OF LITERATURE

This chapter provides a brief history of autism from its first diagnosis in 1943. The different disorders in Autism Spectrum Disorder Spectrum are described and common characteristics discussed. Theories as to the cause of autism are presented. Then, the use of television viewing to motivate children is discussed. The link between physical inactivity and obesity is presented and the benefits of physical activity described. Learning theory, motivation, Applied Behavior Analysis, and contingent and delayed reinforcement are discussed. This chapter concludes with a review of the research studies that involved individuals with autism and physical activity.

History of Autism

Autism was first observed and defined by Leo Kanner in 1943. Through his observations of 11 children, he was able to recognize deficits and/or abnormalities in certain fundamental skills of communication, social interactions, and behaviors such as sensitivity to certain sounds or any subtle changes in their daily routines such as a change in their eating schedule (Kanner, 1943). These deficits have stood the test of time as being strong indicators of autism (Merrick et al., 2004). Kanner further speculated that social class and parental relationships had an impact on whether children developed autism. These aspects, however, are no longer considered valid determining factors

(Volkmar & Klin, 2005). Since Kanner's first observations, many hypotheses have been developed and dispelled over the years. Nevertheless, the social deficits that Kanner recognized remain the defining core for this condition (Klin, Jones, Schultz, & Volkmar, 2003).

In 1944, an Austrian pediatrician named Hans Asperger described 4 children ages 6 to 11 years who had trouble participating socially with other children. Despite these deficits in social interaction, the children exhibited adequate cognitive and verbal skills (Klin, McPartland, & Volkmar, 2005). Hans Asperger's observations involved characteristics similar to those of the children that Leo Kanner observed. However, the research conducted by Leo Kanner the year prior had no influence on the research of Hans Asperger, despite similar social and behavioral characteristics demonstrated by the children they observed.

Hans Asperger's work was not published in English until the 1970s. There were, however, other publications with similar observations and results. For example, Robinson and Vitale (1954) observed 3 children ages 8 to 11 and primarily noticed social inadequacies similar to those observed by Asperger.

Up until the 1950s, many children with a developmental delay such as autism or Asperger's Syndrome were diagnosed as possibly having childhood schizophrenia (Bender, 1959). This diagnosis was later discovered to be erroneous due to better screening that showed children demonstrated other characteristics besides those of schizophrenia (Kolvin, 1971; Rutter, 1970).

Autism Spectrum Disorders

The American Diagnostic and Statistical Manual of Mental Disorders – IV (DSM – IV) and the International Classification of Diseases – 10 (ICD – 10) are the two main resources typically used to define autism (Volkmar & Klin, 2005). Autism is primarily the presence of noticeable impairments or abnormalities in communication development that may demonstrate echolalia, repeating the language of others; neologisms, making up words (Auxter, Pyfer, & Huettig, 2001); difficulty with pronouns, talking in third person; as well as difficulty distinguishing between communication that is literal and that which is figurative (Kuder, 2003).

Individuals with autism also demonstrate impairments with respect to social interactions, such as difficulty in initiating conversation with others, making eye-to-eye gaze, and maintaining relationships (American Psychiatric Association, 2000; Baird et al., 2004; Center for Disease Control, 2007). Another characteristic that is defined by the DSM-IV in children with autism is a level of restricted repetitive and stereotyped patterns of behavior such as hand flapping and unusual adherence to specific, nonfunctional routines or rituals (American Psychiatric Association, 2000; World Health Organization, 1993).

Furthermore, other characteristics have been known to accompany the communication barriers, social deficiencies, and abnormal behaviors such as abnormal sleep patterns (Honomichi et al., 2002) and deficits in play patterns (Rutherford, & Rogers, 2003). Approximately 25% of individuals who have autism also develop a seizure disorder (Rutter, 1970; Volkmar & Nelson, 1990). Self-stimulatory behaviors such as body rocking, spinning, hand flapping, head nodding, object tapping, gazing at lights, and mouthing are also noted in individuals with autism (Berkeley, Zittel, Pitney, & Nichols, 2001; Lovaas, Newson, Hickman, 1987; Mahone et al., 2006; Rapin, 1997; Sugai & White, 1986).

Specific definitions as well as categorizing both Asperger's syndrome and Autism disorder have been somewhat difficult and controversial among professionals over the years (Klin, Sparrow, & Volkmar, 1997). Due to this confusion, several definitions have been developed for Asperger's syndrome in addition to those found in the DSM-IV (Ghaziuddin, Tsai, & Ghaziuddin, 1992; Klin et al., 1997; Leekam, Libby, Wing, Gould, & Gillberg, 2000; Szatmari, Bryson, Boyle, Streiner, & Duku, 2003; Tsai, 1992; Wing, 1981). As a result of the confusion, diagnostic approaches are somewhat blurred. However, allowing for disagreement as to the diagnosis of these disorders, current data show that differences between autism and Asperger's syndrome do exist (Klin et al., 1997; Lincoln, Courchesne, Killman, Elmasian, & Allen, 1998; Szatmari et al., 2003).

One of the most distinct symptoms of AS is having an obsessive interest in a single object or topic—so much so that the person ignores other objects, topics, or thoughts. Unlike some children with autism, children with AS tend to have good vocabularies and grammar skills and no intellectual disability (CDC, 2010a). However, they usually have other language problems, such as being very literal and having trouble understanding nonverbal communications, such as body language. Other symptoms of Asperger's syndrome may include the following: obsessive or repetitive routines and rituals; motor-skill problems such as clumsy or uncoordinated movements and delays in motor skills; problems with social skills, especially relating to communicating with others; and sensitivity to sensory input, such as light, sound, texture, and taste. They may also get upset at minor changes in their routines, have obsessive interests, and exhibit stereotypic behaviors such as flapping their hands, and rocking their body (CDC, 2010a; National Institute of Health (NIH), 2007).

Rett's syndrome is far less common than autism. According to the U.S. Department of Health and Human Services (2003), approximately 1 in every 10,000 to 15,000 girls are diagnosed with the disorder (U.S. Department of Health and Human Services, 2003). This particular disorder has been observed exclusively in females (Armstrong, 1997). Normal development is observed in the prenatal and perinatal stages of life followed by a marked or obvious period of developmental delays and the onset of self-stimulatory behaviors such as hand flapping and a marked slowing in head growth. Rett's syndrome is also associated with severe or profound intellectual deterioration (Armstrong, 1997).

Childhood disintegrative disorder (CDD) can sometimes be confused with Rett's syndrome in that it involves normal development up until approximately age two. Then there is a distinct loss of previously acquired skills such as expressive or receptive language, social skills, bowel or bladder control, and motor skills. However, after that, the similarities end. For example, CDD is four times more common in males and Rett's syndrome is exclusively found in females. In addition, the symptoms of Rett's syndrome could appear as early as 5 months where CDD's symptoms appear much later. CDD is extremely rare, occurring in approximately 1 in 100,000 (American Psychiatric Association, 2000; Volkmar, Koenig, & State, 2005).

Finally, pervasive developmental disorder not otherwise specified (PDD-NOS) involves similar developmental delays as the disorders mentioned above but does not fall into any of those categories for autism or other developmental disorders based on the criteria set up in the DSM-IV. This category may include “atypical autism.” Atypical autism does not meet the criteria for autistic disorder because of a late age for its onset, atypical symptomatology, subthreshold symptomatology, or all of these (American Psychiatric Association, 2000).

Other Issues Associated with Autism

Children with autism often have difficulty in school (Auxter et al., 2001). These difficulties are not necessarily due to low intelligence (Bass, 1985; Kern, Koegel, Dyer, Blew, & Fenton, 1982) but their learning may be affected by their self-stimulatory behaviors as well as poor social and communication skills. Furthermore, individuals with autism may demonstrate fine and gross motor delays (Berkeley et al., 2001; Manjiviona & Prior, 1995; Provost, Lopez, & Heimerl, 2007) while trying to perform sports skills that could affect their performance in physical education classes.

Research on brain and head development in children with autism reveals differences when compared to individuals who do not have autism. For example, head circumference at birth starts out as normal in children with autism (Hultman, Sparen, & Cnattingius, 2002; Lainhart et al., 1997; Stevenson, Schroer, Skinner, Fender, & Simensen, 1997) but when measured after the newborn period, the front occipital head circumference tends to be larger in individuals with autism than in the general population (Courchesne et al., 2001; Davidovitch, Patterson, & Gartside, 1996; Gillberg & de Souza, 2002; Lainhart et al., 1997; Stevenson et al., 1997; Woodhouse et al., 1996). In addition, those who were born with larger head circumference had greater risk than those with a normal size head to have a later diagnosis of autism spectrum disorder **(**Bolton, Roobol, & Allsopp, 2001**)**.

Tunnel vision has been found to be more common in individuals with autism **(**Bryson et al., 2004; Landry & Bryson, 2004; Rincover & Ducharme, 1987). These children are known to have a hard time disengaging attention from one stimulus to another **(**Bryson et al., 2004; Landry & Bryson, 2004**).** They may have some difficulty in visual discrimination such as distinguishing between colors or shapes of an object **(**Rincover & Ducharme, 1987).

Individuals with autism may also show greater incidence of psychological disturbances and mental health issues to varying degrees (Abramson et al., 1992; American Psychiatric Association, 2000; Howlin, 2004; Lainhart, 1999; Lainhart & Folstein, 1994; Tantam, 1991). There has been a higher incidence of depression, bipolar disorder, anxiety, psychotic disorders, and aggression in children with autism than children in the general population **(**Bradley, Summer, Wood, & Bryson, 2004; Gadow, DeVincent, Pomeroy, & Azizian, 2004**;** Ghaziuddin, Ghaziuddin, & Greden, 2002; Ghaziuddin & Greden, 1998; Ghaziuddin, Weidmer-Mikhail, & Ghaziuddin, 1998; Gillberg & Billstedt, 2000; Kim, Szatmari, Bryson, Streiner, & Wilson, 2000**;** Morgan, Roy, & Chance, 2003; Muris, Steerneman, Merckelbach, Holdrinet, & Meesters, 1998**;** Pearson et al., 2006**;** Sturm, Fernell, & Gilberg, 2004). According to Ghaziuddin et al. (2002), depression is possibly the most prevalent psychiatric condition in individuals with autism. Interestingly, most children with autism who suffer from depression showed no family history of depression **(**Ghaziuddin, & Greden, 1998**).**

Legislation and Autism

In 1975, Congress passed the Education for All Handicapped Children Act (EHA) or Public Law (P. L.) 94-142. This law was designed to provide a free and appropriate education for children and adults with disabilities (Library of Congress, 2007). Under P. L. 94-142 (1975), there were 11 categories of disability defined for which children could receive special education services. Under this law, autism was not an identified category. Instead, children with autism were categorized as “other health impaired” (Aleman, 1991) or “emotionally disturbed” (Huefner, 2000). Individuals who were placed into this group were defined as exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affected educational performance: (a) an inability to learn, which cannot be explained by intellectual, sensory, or health factors; (b) an inability to build or maintain satisfactory interpersonal relationships with peers and teachers; (c) a general pervasive mood of unhappiness or depression; or (d) a tendency to develop physical symptoms or fears associated with personal or school problems (Education for all Handicapped Children Act [EHA], 1975).

In 1990 P. L. 94-142 was reauthorized as P. L. 101-476 (1990)-, otherwise known as the Individuals with Disabilities Education Act (IDEA). This change in 1990 came about after 15 years of implementing P. L. 94-142. Because children with autism exhibited such unique characteristics that were different from children with serious emotional disturbances, the lawmakers created a new category of autism (IDEA, 1990). Under IDEA, autism became a defined category eligible for special education services. The definition for autism in the latest reauthorization of IDEA (2004) specifically stated that:

> (a) Autism means a developmental disability significantly affecting verbal and nonverbal communication and social interaction, generally evident before age 3 that adversely affects a child's education performance. Other characteristics often associated with autism are engagement in repetitive activities and stereotyped movements, resistance to environmental change or change in daily routines, and unusual responses to sensory experiences. The term does not apply if a child's educational performance is adversely affected primarily because the child has an emotional disturbance…
> (b) A child who manifests the characteristics of "autism" after age 3 could be diagnosed as having "autism"… (IDEA, 2004).

Diagnosis of Autism

In order for an individual to be categorized as having autism according to the DSM–IV, certain deficiencies or abnormalities must be present in the categories of social interaction, communication, and stereotypical behaviors. Each of these categories includes four criteria that could be present in individuals with autism. A total of six criteria need to be met with at least two criteria coming from social interaction, at least one criterion coming from communication, at least one criterion coming from stereotypical behaviors, and the final two criteria coming from any of the three categories of social interaction, communication, and stereotypical behaviors.

Autism has manifested itself as early as birth, although the characteristics are harder to determine at this time than at a later age. Certain symptoms of autism usually occur prior to age 3. These are typically noticed by the parents. In approximately 30% to 54% of children diagnosed with autism, the parents noticed symptoms before the child's first birthday and in close to 80% of the children, symptoms were noticed by 2 years of age (Chawarska & Volkmar, 2005). Such behaviors as not giving the parent attention when their name is called, avoiding eye contact, flapping their hands, and/or rocking their body can be indicators of autism (CDC, 2010a; Robins, Fein, Barton, & Green, 2001).

Other characteristics include not pointing at objects that they show an interest in, not understanding the concept of pretend games, having trouble understanding the feelings of others, demonstrating delays in speech skills and language formation, repeating words that others may say (echolalia), and getting upset when minor changes occur (CDC, 2010 a). Interestingly, children may develop normally up until age 1 or 2 before such characteristics are present (American Psychiatric Association, 2000). When diagnosing autism, it is important to determine that the delays are not attributed to symptoms that are categorized as other disorders such as Rett's syndrome or childhood disintegrative disorder (American Psychiatric Association, 2000).

Theories that May Explain the Cause of Autism

There is much debate as to what causes autism. Earlier speculation of possible causes of autism was linked to social influences as well as childhood upbringing. Leo Kanner first stated that the primary cause of autism was due to poor parenting or parental neglect (Kanner, 1943). Over the years, other theories have been proposed. A controversial theory is that autism is caused by reactions to the measles, mumps, and rubella (MMR) vaccinations (Wakefield et al., 1998). This theory was refuted in the Institute of Medicine (IOM) Report presented by the Center of Disease Control and Prevention. Conclusions from the findings of the report stated that there was insufficient evidence to claim that MMR vaccinations were linked to any cause of autism (CDC, 2010a; Hornig et al., 2008).

Food allergies of such foods as dairy or wheat have been theorized as a possible cause of autism. Alberti, Pirrone, Elia, Waring, and Romano (1999) claimed that increased levels of urinary peptides may lead to metabolic abnormalities that affect the central nervous system and may lead to characteristics of autism (Black, Kaye, & Jick, 2002; Le Couteur, Trygstad, Evered, Gillberg, & Rutter, 1988; Pedersen, Liu, & Reichelt, 1999; Reichelt, 1997; Whitley & Shattlock, 2002).

Other theories speculating about the causes of autism include antibiotic overuse which may "...disrupt the protective effect of indigenous intestinal organisms..."(Hansen & Ozonoff, 2003; Sandler et al., 2000); disruptions in the autoimmune system (Hansen & Ozonoff, 2003); serotonin synthesis (Chugani et al., 1999; Chugani et al., 1997) and exposure to environmental toxins during infancy (Bernard, Enayati, Redwood, Roger, & Binstock, 2001; Edelson & Cantor, 1998; London & Etzel, 2000).

Finally, extensive research in recent years is showing that there may be a genetic abnormality that can lead to autism (CDC, 2010a). In a massive study comprising 50 centers in North America and Europe, Szatmari et al. (2007) identified a sample of over 1400 families for this research. Of that number, 1,168 families were eligible for inclusion in the study. Researchers were able to detect chromosomal abnormalities in almost all of the individuals with autism. The chromosomal abnormalities affect the transmission of signals between neurons, thus affecting brain development.

Prevalence of Autism

In 1985, the prevalence of autism was as little as 4 to 5 individuals diagnosed with autism out of 10,000 (Yeargin-Allsop et al., 2003). Recent research has determined that the incidence figure is much higher. The Center for Disease Control and Prevention (2010b) has established that approximately between 1 in 80 to 1 in 240 with an average of 1 in about every 110 children have some form of autism, up from its previous estimation of 1 in about every 150 individuals just 4 years ago in 2007. Therefore, it could be estimated that there are approximately 730,000 or more individuals between the ages of 3 and 21 that have some level of an ASD if the estimates have remained constant over the past 20 years (CDC, 2010a). It was reported by the CDC's Utah Autism Developmental Disabilities Monitoring Network (UT-ADDM) from their 2002 study, 1 in 133 children aged 8 in Utah were diagnosed with autism. This was the third highest in the nation at that time (CDC, 2007). However, a study that was published in 2011 from the University of Utah found that that number has increased 100% in the state of Utah to 1 in 77, (Pinborough-Zimmerman, Bakian, Fombonne, Bilder, Taylor, & McMahon, 2011).

In a recent report, the Autism and Development Disabilities Monitoring (ADDM) Network that works in association with the CDC cited a marked increase in the number of 8-year-old children who have been diagnosed with autism from 2004 to 2006 (ADDM, 2009). The increase in diagnosis each year of children with autism has made it the fastest growing developmental disorder. Some speculation as to the reasons for this increase in the prevalence are that (a) more children are manifesting the symptoms; (b) the tools to diagnose autism are improving (CDC, 2010a); and (c) creating a category for autism spectrum disorder in IDEA 1990 as opposed to categorizing those children as "emotionally disturbed" (Baird et al., 2004; Keen & Ward, 2004).

According to the 15th Annual Report to Congress (1992), it was estimated that there were 5,208 students age 6-21 with autism being serviced under IDEA in the U. S. and outlying areas **(**U. S. Department of Education, 2009**).** In the latest available report, the 29th Annual Report to Congress (2007), the number of those children with autism receiving services increased to 193,637, representing a nearly 37-fold increase (U. S.

Department of Education, 2007). Interestingly, autism is found to be four times more prevalent in boys than in girls (CDC, 2007).

Because there are now more children who are diagnosed with autism due to better diagnostic tools and more mild cases being categorized as having autism, there are more children being classified as being eligible for special education services under IDEA (2004). Due to this increase of eligibility in children with autism, there is a greater need for physical education services for this population (U. S. Department of Education, 2005).

Using Technology for Children Diagnosed with Autism

With the increase in the number of children with autism in the schools, certain challenges may present themselves to teachers. For example, lack of knowledge of autism by some teachers may make it difficult to properly instruct children with autism who manifest maladaptive behaviors. This may pose deficiencies in instruction, thus straining the relationship of the teacher and the student with autism and disrupting educational opportunities due to possible unwanted behaviors (Robertson, Chamberlain, & Kasari, 2003).

In recent literature, it has been reported that there is an increase in the number of children who are watching television in their leisure time. It is estimated that American children spend an average of 38 hours per week using media (television, computer use, video game playing, and video viewing combined) as a form of entertainment. Of that time, more than 20 of those hours are spent watching television. Furthermore, it has been projected that students will spend more time watching television than they will spend in class during their high school career. This increased viewing of television has been shown to increase adiposity in children when compared to other sedentary activities such as reading and doing home work (Clocksin, 2005). Television viewing also lowers bone mineral content. However, researchers found that when physical activity was incorporated as a part of a child's lifestyle, television viewing was no longer associated with low bone mineral content (Vicente-Rodriguez et al., 2009).

Because television viewing is so motivating to children, technology could be used as an effective tool to motivate individuals with autism to learn new behaviors such as increasing their physical activity. Technology has been shown to help children with autism in other aspects of education such as learning a new language (Bosseler & Massaro, 2003), improving vocabulary acquisition (Moore & Calvert, 2000), and improving developmental skills (Charlop-Christy, Le, & Freeman (2000). Technology may help free up teachers' and parents' time to do other things (Coleman-Martin, Heller, Cihak, & Irvine, 2005).

There currently are very few research studies that have used technology to motivate children to be more physically active. Increasing the duration a child with autism pedals a stationary cycle during a particular bout of exercise by using a television that turns on or shuts off contingently is not present in the research literature. However, the process of utilizing contingent reinforcement to establish new behaviors has been effective in other populations. For example, contingent reinforcement was shown to increase pedaling duration on a stationary cycle with children who are obese (Faith et al., 2001). There has also been some evidence to show that individuals who have intellectual disabilities have increased pedaling time on a cycle using contingent reinforcement (Caouette & Reid, 1985; Mathieson, 1991).

Physical Activity Levels of Children and the Link to Obesity

The CDC reported that in 2007, only 30% of high school students attended physical education class daily, which was down from 42% participation in 1991 (CDC, 2010b). Furthermore, in 2005, 45% of ninth graders participated in physical education classes whereas only 22% of the twelfth graders participated in any type of physical education class (CDC, 2006). Even with approximately 77% of children between the ages of 9 and 13 years of age reporting that they engage in free time physical activity (CDC, 2003), participation in physical activity seems to decrease as children become older. The CDC (2005b) reported that 32% of individuals between the ages of 18-24 participated in physical activity that is of sufficient intensity (60 minutes of moderate or vigorous-intensity physical activity daily); that number increases to 36% at 65 years of age and older. Furthermore, 10% of individuals between the ages of 18-24 reported being completely inactive compared to 25% of those age 65 + years (CDC, 2007).

This has prompted the CDC to set forth recommendations for youth on what they should be getting in terms of physical activity to achieve an optimal level of health. Those guidelines recommend that children and adolescents engage in at least 60 minutes of physical activity at moderate intensity on most, preferably all, days of the week (CDC, 2010a; CDC, 2005a).

According to the CDC (2010b), obesity has more than tripled in children over the past 30 years. In fact, the CDC has reported that obesity has increased in 6-11 year olds from 7% in 1980 to 20% in 2008. Furthermore, the CDC reported that obesity of adolescents ages 12-19 has increased from 5% in 1980 to 18% in 2008 (CDC, 2010b; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). The American Heart Association (2010) has stated that 1 in 3 children are overweight or obese, almost triple the rate in 1963 and approximately 25 million children and adolescents are at risk of becoming overweight or obese.

Risk Factors in Children Due to Obesity

Due to the increase in the prevalence of obese and overweight children over the past several decades, the American Heart Association has stated that childhood obesity is one of the nation's leading health threats. More children are developing health conditions that are normally associated with adults, such as high blood pressure, elevated cholesterol, and type 2 diabetes (American Heart Association, 2010; Gaylor & Condren, 2004; Kiess et al., 2001). Moreover, given their level of inactivity, researchers have shown that, over the years, youth in the general population are becoming more at risk for these illnesses at a younger age than in the past due to obesity (Gascon et al., 2004; Gaylor & Condren, 2004; Gordon-Larsen et al., 2004; Hesketh et al., 2004; Kiess et al., 2001; Paradis et al., 2004; Williams et al., 2004).

In addition, children and adolescents who are overweight are more likely to be overweight or obese as adults. Children who are overweight at the age of 10-15 have an 80% chance of becoming obese when they reach age 25 (CDC, 2010b; Casey, Dwyer, Coleman, & Valadian, 1992; Ferraro, Thorpe, & Wilkinson, 2003; Gordon-Larsen et al., 2004; Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Adults who are obese are at a greater risk for heart disease, high-blood pressure, stroke, diabetes, some types of cancer, and gallbladder disease (U. S. Department of Health and Human Services, 2001).

Not only are there physical problems associated with obesity, but a number of emotional issues are often related and can have just as strong of an impact. One study examined 1157 elementary school aged children (5-10 years of age) at baseline and then again at a 3-year follow-up. They found that the self-efficacy of children who had a higher body mass index (BMI) was considerably lower than students with a lower BMI (Hesketh et al., 2004).

The ramifications of inactivity go beyond health issues; they also can have financial consequences. The research shows that people who possess increased risk factors caused by obesity can face increased medical costs (Pratt, Macera, & Wang, 2000).

Physical Activity Levels in Children with Disabilities and the Link to Obesity

It has been reported in the literature that individuals who have a disability have a tendency to be less physically active than individuals who do not possess a disability (CDC, 2007). In a recent review of literature, 38 articles that reported on obesity and children with disabilities stated that the prevalence of overweight and obesity in children with disabilities was almost twice that of their peers without a disability (Reinehr, Dobe, Winkel, Schaefer, & Hoffmann, 2010). More specifically, it has been shown that children with autism are less moderately active and have less opportunity for activity as compared to other children who are not diagnosed with autism (Rosser & Frey, 2003). Obesity due to inactivity in children with autism has been shown to be similar to that of the general population (Curtin et al., 2005).

The behaviors of inactivity in children with disabilities can carry over into adulthood. In 2003, the lack of leisure physical activity or the prevalence of sedentary behaviors among adults with disabilities was 53% compared with 34% among people without a disability (CDC, 2005a). These issues with obesity and inactivity in individuals with disabilities are concerning.

Other Risk Factors in Individuals with Disabilities

Negative health risk factors similar to the general population are often manifested with more intensity in individuals with disabilities. In 2002, high cholesterol affected 19% of those individuals with disabilities and 17% of those without disabilities. High blood pressure affected 37% of individuals with disabilities and 29% of those without disabilities. Obesity affected 42% of adults with disabilities and 28% of those adults without disabilities (CDC, 2005b).

The CDC (2007) presented results from a self-report on health status that showed differences among those with a disability and those without. It was reported that 32.3% of those individuals with a disability reported having “very good” or “excellent” health compared to 65.9% of those individuals without a disability. It was further reported that 30% of individuals with a disability had “fair” or “poor” health as opposed to just 6.1% among those individuals that did not have a disability (CDC, 2007). These discrepancies led the U. S. Department of Health and Human Services to state that greater efforts need to be made to accommodate the health needs of those with disabilities (U. S. Department of Health and Human Services, 2005).

In a study conducted by Curtin et al. (2005), researchers examined 42 patient records of children with autism from a tertiary care clinic at the Tufts-New England Medical Center in Boston. They reported that the percent of children with autism who were at the time considered overweight (BMI > 95th percentile) was 19%. An additional

35.7% were at risk to be overweight (BMI $\geq$ 85th percentile). Therefore, 54.7% of children with autism were either overweight or at risk of being overweight. The researchers concluded that children with autism have the same tendency to become obese as children without autism. This information can lead to the same conclusion that children with autism are at risk for complications that accompany obesity.

According to the 2000 U. S. Census Bureau, there are some 50 million Americans who have some type of disability. Of those 50 million individuals with disabilities, approximately 1 to 1.5 million Americans have some form of autism (U. S. Census Bureau, 2000). The need to increase physical activity in all children including those with disabilities is evident in the literature.

Benefits of Physical Activity

Physical activity can reduce certain health risk factors and can diminish the threat of premature death in general. Studies have shown that physical activity can reduce the risk of coronary heart disease, hypertension, colon cancer, and diabetes mellitus (CDC, 1996; Haapanen et al., 1997; Kriska, 2000; Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006; Slawta, McCubbin, Wilcox, Fox, Nalle, & Anderson, 2002; Thune, & Furberg, 2001; Wannamethee, Shaper, & Walker, 2000). Physical activity has also been shown to decrease cholesterol levels, strengthen bones and muscles, and lower levels of obesity that may lead to cardiovascular disease (CDC, 2007).

Physical activity helps to reduce anxiety and stress, and it has been shown to increase self-esteem (CDC, 2007; Paluska & Schwenk, 2000; Penedo & Dahn, 2005; Penninx et al., 2002; Richardson et al., 2005) and improve cognitive functioning (Kramer & Erickson, 2007; Lautenschlager et al., 2008; Sibley & Etnier, 2003). Research in individuals with Alzheimer's disease has shown decreases in dementia when they participated in leisure activities, such as walking (Scarmeas, Levy, Tang, Manly, & Stern, 2001). Other research has suggested that physical activity may provide short-term improvement in the classroom by improving concentration (Taras, 2005). Finally, by providing enjoyable, successful, and positive opportunities in physical activity at an early age, individuals can help establish positive behaviors to promote being physically active early on that will help them to be active on a regular basis throughout their lifetime (CDC, 1996).

Research has shown that physical activity has multiple positive effects on individuals with autism. The literature reports that physical activity served to improve gross motor skills (Best & Jones, 1974, Lang et al., 2010) and fitness levels (Fragala-Pinkham, Haley, O'Neil, 2008; Lang et al., 2010; Lochbaum & Crews, 2003; Pitetti, Rendoff, Grover, & Beets 2007; Yilmaz, Yanardag, Birkan, & Bumin, 2004), decrease maladaptive behaviors and stereotypical behaviors and increase on task behaviors (Allison, Basile, & MacDonald 1991; Celiberti et al., 1997; Elliot et al., 1994; Gordon, Handleman & Harris, 1986; Kern, Koegel, & Dunlap,1984; Kern et al., 1982; Lang et al., 2010; Levinson & Reid, 1993; Powers, Thibadeau, & Rose, 1992; Prupas & Reid, 2001; Reid, Factor, Freeman, & Sherman, 1988; Rosenthal-Malek & Mitchell, 1997; Waters & Waters, 1980).

When looking at improving stereotypical behaviors more specifically, one study examined adolescents and the effects of exercise on self-stimulatory behaviors (Rosenthal-Malek, & Mitchell, 1997). Five adolescent males diagnosed with autism participated in an aerobic condition that consisted of mildly strenuous jogging for 20 minutes in a gym. Each participant jogged independently. They also participated in an academic condition with activities similar to those performed in their classroom. After the two conditions, each participant was evaluated relative to the frequency of self-stimulatory behaviors. Each aerobic condition had a significant effect on limiting unwanted self-stimulation, such as hand waving and rocking back and forth.

A second study (Elliot et al., 1994) examined adults with autism to determine whether participation in aerobic activity would result in a decrease in such maladaptive behaviors as getting off task or disrupting others. Three men and 3 women diagnosed with autism accompanied with mental retardation participated in a three-condition study. The first condition was a nonexercise control condition, which included board games. This condition had little potential to raise heart rate above 90 beats per minute. The second condition was a general motor training that elevated heart rate levels between 90 and 120 beats per minute. Participants could choose between riding an exercise bicycle, using a stair stepper, lifting light weights, or walking on a treadmill. The last condition used vigorous aerobic exercise on a treadmill moving at 4 miles per hour. This treatment elevated heart rates above 130 beats per minute. Each participant performed each condition five times and then the participants were observed in a controlled environment to see if any maladaptive behaviors were present. There were more signs of a decrease in maladaptive behaviors after the participation in the vigorous intensity condition than the lower intensity conditions. There was also a decrease in maladaptive behaviors in these adults following the higher intensity aerobic exercise.

In a third study, Celeberti et al. (1997) examined the effects of participating in different intensities of aerobic activity on self-stimulatory behaviors. A 5-year-old boy with autism participated in two exercise conditions, 6 minutes of slow-paced walking and 6 minutes of moderate and continuous running over a 3-week period. The results indicated that running reduced the frequency of self-stimulatory behaviors with more success than walking.

From these research studies, it is evident that physical activity will not only lower the risk of health problems in this population caused by obesity but physical activity can possibly reduce unwanted behaviors that affect children's education in the classroom.

Learning Theory and Motivation

There are three main approaches that most individuals use to learn. They are the humanistic approach, the information processing approach, and the behavioral intervention approach. The humanistic approach examines learning through inner change with new insight into self and one's environment. Through a humanistic approach, the individual learns because of an element that is self-directed or has intrinsic value (i.e., value is put on learning a new skill or trait to improve oneself such as learning to farm to provide food for sustenance). In other words, the humanistic learning approach puts emphasis on self-understanding, is feeling driven, and chooses activities that are growth enhancing (Swartz, de la Rey, & Duncan, 2004).

The information processing approach takes place when the learner mentally chooses activities that they deemed important to achieve learning. In the information processing approach, there are two levels of learning. The superficial level means you learn something for the sole purpose of remembering it at a later date, for example, remembering answers for an exam simply for the grade. There is also a deeper level of learning in which an individual learns because he/she wants information for the purpose of using it in actual events or processes; for example, learning to tie a shoe is necessary so you will not trip and fall. This learning has deeper meaning because the learner uses the information for practical purposes and not just to get a grade on a test.

Learning through a behavioral approach refers to developing a new behavior or termination of an unwanted behavior through the use of some type of consequence, usually reinforcement or punishment. Administering reinforcement or punishment as a consequence of a behavior is paramount to the behavioral approach to learning. This approach was first introduced in the early years of the twentieth century by John Watson (1878-1958). Through this approach, there was a strong emphasis placed on learning rather than other areas of psychology. The behavioral approach is based on the principle of operant conditioning. The most influential behaviorist was B. F. Skinner (1904-1990) who defined the process of operant conditioning. His main assumption was that all behavior is under the control of reward or reinforcement. He postulated that a behavioral response would increase when a reward system is in place and decrease when punishment was used as a consequence of a behavior (Eysenck, 2009). Operant conditioning suggests that the consequences of a behavior will determine if that behavior is repeated or not in the future. If the behavior is reinforced, it will likely increase in the future; if a behavior is punished, it will likely decrease in the future (Lavay et al., 2006; Skinner, 1968; Swartz et al., 2004). The approaches that are used in motivation and learning are similar (Woolfolk, Winne, & Perry, 2006).

There are a number of theories that are associated with motivation. Motivation is usually defined as the internal state of an individual that most likely arouses, guides, and maintains his/her behaviors. Motivations to arouse, guide, and maintain behaviors can be internal, or intrinsically driven. When individuals are intrinsically motivated, they need not seek out external rewards but rather, they are motivated by internal feelings that have powerful worth.

In the alternative, when motivation to act is facilitated by outward or extrinsic rewards such as a grade, an award, praise, or other stimuli that has little to do with the task at hand, but rather what is received by completing the task, this is considered extrinsic motivation.

Extrinsic reinforcement is an effective tool to learn or change a behavior such as increasing physical activity. In a literature review conducted by Dishman and Buckworth (1996), 127 studies from 1965 to 1995 were examined to determine the efficacy of interventions implemented as a motivator to increase exercise. The researchers reported that implementing interventions to increase physical activity had a moderately large effect. The researchers concluded that interventions based on behavior modification that combined reinforcement and stimulus control had the greatest success in promoting exercise (Dishman & Buckworth, 1996).

The use of extrinsic reinforcement to motivate learning has been effective in improving certain behaviors in individuals with autism. Extrinsic factors have been shown to enhance an individual's intrinsic interest in activities, thus motivating an individual to learn or even participate in an activity (Pierce & Cheney, 2004). Extrinsic reinforcement has been shown to improve certain skills such as toilet training and verbal skills as well as increasing skill development and appropriate behaviors in individuals with autism (Bregman, Zager, & Gerdtz, 2005), especially when administered at a young age (Eikeseth, Smith, Jahr, & Eldevik, 2007; Woods & Wetherby, 2003). However, the reinforcer that is used for the extrinsic motivation must be powerful enough to engage the person to participate in the preferred behavior. If the person with autism has no value for the reinforcer, they will not be motivated to participate in the preferred behavior (Bregman et al., 2005).

Increasing the motivation of individuals to learn a preferred behavior may take some planning. Providing an environment that will allow the individual with autism to have a sense of success increases the probability of motivation. Setting up a reinforcement plan that determines how reinforcement is administered is a key to motivation as well. Finally, giving the individual with autism a choice of reinforcers will increase the probability the individual will be motivated because they have chosen the reinforcer that has value to them (Paul & Sutherland, 2005).

Applied Behavioral Analysis

A behavioral approach that has been effective in modifying or augmenting certain behaviors is Applied Behavior Analysis (ABA) (Anderson & Romanczyk, 1999; van Bilsen, 1995; U. S. Department of Health and Human Services, 1999; Weeden, & Poling, 2010). ABA is based on the principles of operant conditioning that were expressed by Skinner (Ringdahl, Kopelman, & Falcomata, 2009). ABA uses the concepts of reinforcement and punishment to bring about behavior change (Ringdahl et al., 2009). ABA's concept of using reinforcement techniques to promote wanted behaviors and punishment techniques to diminish unwanted behaviors is based on learning theory (Baer, Wolf & Risley, 1987; Sulzer-Azaroff & Mayer, 1991).

Components that are considered part of ABA do not cure autism; however, they have been shown to be very beneficial in improving the lives of individuals who have autism (Schreibman & Ingersoll, 2005). Some of those ABA approaches that have been shown to work well with children diagnosed with autism to bring about changes in behavior are the behavioral approaches using reinforcement and punishment (Lovaas, 1981; Lovaas, 1993; Pierce & Cheney, 2004).

A component that is crucial for changing behaviors under ABA is providing a reinforcer following a designated response. However, finding the proper reinforcer that is actually motivating for an individual with autism may be somewhat of a challenge. Researchers have created several methods to identify potential reinforcers (Weeden & Poling, 2010).

One of the more common techniques for finding a proper reinforcer is selection-based preference assessment. In this technique, potential reinforcers are presented individually or alongside multiple possible reinforcers to the person. The reinforcer that is chosen by the person is considered the most effective reinforcer (Weeden & Poling, 2010). A second technique to determine a proper reinforcer is duration-based assessment. In this method, different reinforcers are presented and the reinforcer that the participant spends the most time with is determined to be the effective reinforcer. The final method to determine an appropriate reinforcer is more of an indirect method such as asking parents, teachers, or others who work with the individual which reinforcer he/she values most (Weeden & Poling, 2010).

ABA approaches have been shown to be an effective technique for individuals with autism to improve certain aspects of their lives. ABA specifically improved areas in language skills (Mancil, Conroy, Nakao, & Alter, 2006; Rousseau, Krantz, Poulson, Kitson, & McClannahan, 1994), toilet training (Cicero & Pfadt, 2002), cognitive ability, positive behaviors, learning, functional communication, and the general quality of life. ABA also has been used to decrease the frequency of aberrant behaviors and social problems (Dillenburger, Keenan, Gallagher, & McElhinney, 2004; Eikeseth et al., 2007; Harris, & Delmolino, 2002; Jensen, & Sinclair, 2002; Kroeger, & Nelson, 2006; Polirstok, Dana, Buono, Mongelli, & Trubia, 2003; Steege, Mace, Perry, & Longenecker, 2007).

A 2010 review of literature confirmed the effectiveness of behavior change in children with autism when using ABA approaches specifically reinforcing wanted behaviors. A total of 97 articles that implemented the ABA approach of reinforcement with this population to teach skills were examined. Each of those articles showed that positive reinforcement was a successful technique to teach skills to participants with autism (Weeden & Poling, 2010).

A meta-analytic review of 11 additional articles examined intervention approaches designed to improve behavior in children with autism (Peters-Scheffer, Didden, Korzilius, & Sturmey, 2010). Researchers observed that the children who received some type of behavioral intervention improved cognitively compared to those who did not receive behavioral intervention. The behavioral intervention groups outperformed the control groups on IQ nonverbal, IQ expressive and receptive language, and adaptive behaviors.

Yet another review of literature (Lang et al., 2010) examined different research studies that involved individuals with autism and physical activity. From this review, the researchers observed 18 studies. These research studies were evaluated in terms of: (a) participant characteristics, (b) mode of exercise, (c) what was used to increase exercise,

(d) outcomes of each article, and (e) the methodology used in the research. The researchers observed from the articles that there were a total of 64 participants with ASD aged 3-41. The majority of the research articles examined physical activity and its effects on stereotypical and off-task behaviors. Twelve of the articles used jogging as the mode of exercise (Allison et al., 1991; Celiberti et al., 1997; Elliot et al., 1994; Gordon et al., 1986; Kern et al., 1984; Kern et al., 1982; Levinson & Reid, 1993; Powers et al., 1992; Prupas & Reid, 2001; Reid et al., 1988; Rosenthal-Malek & Mitchell, 1997; Watters & Watters, 1980). Three articles incorporated a swimming/water aerobics program to examine the effects this mode of exercise had on improvements in gross motor development and in the fitness (Best, & Jones, 1974; Fragala-Pinkham et al., 2008; Yilmaz et al., 2004). Two other research articles examined how exercise capacity changed during walking on a treadmill, riding a stationary cycle, and weight lifting (Lochbaum & Crews, 2003; Pitetti et al., 2007). Finally, one article examined different teaching styles to increase exercise behavior while snowshoeing or jogging (Todd & Reid, 2006). From this review, the researchers determined that physical activity was beneficial to individuals with ASD.

In the aforementioned meta-analysis, only one study used an intervention to encourage children with autism to be physically active (Todd & Reid, 2006). This article was the only study in the literature that involved exercise as the dependent variable to evaluate whether a self-management/monitoring procedure would increase walking or snowshoeing in individuals with autism. The self-management procedure consisted of placing stickers on a board at the conclusion of each exercise bout. These stickers could be redeemed for edible reinforcers. Verbal prompts were used to teach the skills and to encourage the participants to continue. All reinforcers were faded over time. Participants increased the distance of walking/snowshoeing by 400% (Todd & Reid, 2006).

Contingent and Delayed Reinforcement

To date, there are no other research studies in the literature that have used contingent reinforcement to encourage physical activity in children with autism. However, contingent reinforcement has been shown to be successful to increase physical activity in individuals with intellectual disabilities and children who are obese (Caouette & Reid, 1985; Coleman et al., 1997; Faith et al., 2001; Mathieson, 1991).

Both delayed reinforcement (Roemmich et al., 2003) and contingent reinforcement (Faith et al., 2001) have been shown to increase physical activity in the general population. It has been mentioned that immediate reinforcement may have a stronger impact on changing behaviors than delayed reinforcement (Mayhew & Anderson, 1980). In a study by Mayhew and Anderson (1980) researchers concluded that there was a significant difference in the increase of on-task working behaviors in educational settings of adolescents with intellectual disabilities using immediate reinforcement compared to delayed reinforcement. Immediate reinforcers have also been shown to be the preferred method chosen by children and adolescents diagnosed with ADHD (Luman, Oosterlaan, & Sergeant, 2005; Price, Martella, Marchand-Martella, & Cleanthous, 2002) and in another study with children diagnosed with severe disabilities (O'Reilly, Renzaglia, & Lee, 1994). One point to take into consideration is if the reinforcer is delayed, it is possible that the reinforcer is reinforcing other behaviors that are not wanted (Powell, Symbaluk, & MacDonald, 2002).

Even with these findings, to date, there is no research that has been conducted that compares contingent and delayed reinforcement to determine which type of reinforcement would be more effective in motivating children with autism to be more physically active.

Moreover, motivational strategies should be investigated further with respect to children with autism. According to the literature, there is a trend in this population to become more obese over time. This research study can help to stimulate ideas to increase physical activity, and as a consequence, minimize health problems brought on about by obesity.

CHAPTER 3

METHODS

For the purposes of maintaining the integrity of the final research study, a pilot study was conducted to make sure the equipment was functioning properly as well as to observe the effectiveness of the research protocol. From the results of the pilot study, certain methodological questions were answered in this chapter such as the demographics of the population that was used, how the population was gathered, as well as the validity of some of the equipment. Furthermore, procedures from the findings of the pilot study such as heart rate calculation, the protocol that each participant followed, and statistical analysis of the data are explained.

Pilot Study

Seven children (2 females, 5 males) between the ages of 6 and 15 from Carmen B. Pingree Center for Children with Autism were chosen by their classroom teachers. Each participant agreed to take part in a 3-week pilot study.   There was a separate day of testing for each participant before the baseline phase. This day of testing was used to determine target heart rate zone (THRZ) as well as at which level each participant would pedal throughout the entire study. The baseline phase, the delayed reinforcement phase, and the contingent reinforcement phase were all 5 days long and took place during a school week.

Resting heart rate was obtained for each participant in order to determine THRZ. Resting heart rate was calculated by taking the average of the 5 lowest heart rates from the heart rate monitor during a 5-minute period where the participant sat and watched a video. Then the THRZ was calculated for each participant using the Heart Rate Reserve (HRR) formula (ACSM, 2006). The THRZ was then programmed into the heart rate monitor. The next step was to determine at what level each participant would pedal throughout the study. Each participant was instructed to pedal the cycle at an intensity of level 1 for 5 minutes. If the participant did not reach their THRZ, resistance was then increased to the next level and he/she would pedal for 3 additional minutes. This protocol was followed at each level continuously without any rest periods until each participant pedaled the cycle in their THRZ. This level would be set for this participant each exercise bout throughout the pilot study.

After THRZ and level were determined for all participants, the baseline phase began. Each day the participant would arrive at the testing room, a staff member from the Pingree Center was present and would assist the participant in putting on the heart rate monitor. Each participant was then instructed to pedal as long and hard as he/she could during a 30-minute bout of exercise. They were not required to pedal for the full 30 minutes; when they elected to stop, they could stop. This was followed throughout baseline and the two treatment phases.

Each day of the study, there were at least three research assistants present. One research assistant would provide verbal encouragement and maintain the safety of the participant during the study. The research assistant was only allowed to make comments such as, “keep going” when the participant was slowing down or “great pedaling speed” when they were pedaling in their THRZ. Another research assistant was assigned to film the participant pedaling, to secure the integrity of the study. A third research assistant would time the duration of each exercise bout with a stopwatch. During baseline, only the time that was spent in the participant's THRZ was recorded.

During the second week, each participant was randomly assigned to receive delayed reinforcement (treatment 1) or contingent reinforcement (treatment 2) first. Randomly assigning participants to the order of the particular treatment would serve to minimize any learning effect across the study and changes would be due to the treatment and not to learning.

For the period of week 3, the participants took part in the other treatment. For example, if a participant received contingent reinforcement during week 2, they would receive delayed reinforcement during week 3. Each participant was instructed to reach and maintain his/her target heart rate for as long as possible in that 30-minute bout.

Each participant was asked to choose a DVD they enjoyed watching from several DVD's to view for the delayed and contingent reinforcement phases. The participant would choose a DVD each day that he/she participated in the delayed or contingent reinforcement phases. Having them choose the DVD gave them the motivation to pedal in their THRZ during the each phase. No DVDs were watched during the baseline phase.

For the delayed treatment, the participants were told to pedal the cycle and they could watch their selected DVD when they finished pedaling for as many minutes as they pedaled. For example, if they pedaled for 3 minutes in their THRZ, they would be allowed to watch the selected DVD for 3 minutes.

During the contingent treatment phase, the power to the DVD player was turned on and the DVD that was selected was placed in the DVD player with the television turned off. A heart rate monitor was placed on the participant. The heart rate monitor was used to activate the Entertrainer. The THRZ of each participant was programmed into the Entertrainer component. The Entertrainer operates similar to a television remote control device. When the participant pedaled the cycle at the speed to increase their heart rate into their THRZ, a television with a DVD player was activated via the Entertrainer for the participant to watch his or her selected DVD. When the participant's heart rate dropped below their THRZ for a period of 20-30 seconds, the Entertrainer reduced the volume on the television. If the participant stayed below their target heart rate for over a minute, the Entertrainer would then turn the television off. To turn the television back on and increase the volume, the participant had to increase the work output to increase his/her heart rate into their THRZ. The television would turn on immediately when they reached their THRZ.

A second purpose of the pilot study was to determine if pedaling on a recumbent stationary cycle had any effect on classroom behaviors of the participants. To determine this, observations were made in a classroom setting for a minimum of 15 minutes each time. To gather the baseline data, observations of the participant in his/her classroom were made prior to the exercise sessions. The participant then attended the 30-minute exercise session. After the exercise session, the participant returned to the classroom and was observed for another 15- to 20-minute time segment. Each participant was observed in the classroom for at least 3 days during each treatment phase.

To maintain the integrity of the research, each classroom session was videotaped. The video camera was positioned in an observation room with a one-way window out of view of the children. The research assistants then scored the classroom behaviors. The score sheet that was used is based on recommendations from the Behavioral Observations of Students in Schools (BOSS; Appendix A). Using this model, both passive and active behaviors could be recorded (Shapiro, 2004).

Video recording is an acceptable and advantageous way of recording data (Glesne, 2006). The events may be preserved on video if there are a few observers to help and if there are multiple testing sessions throughout the day. Having video recordings also allowed for playback multiple times or at slower speeds in order to more accurately record data.

The behaviors that were the most disruptive to the student and the class were determined and operationally defined by the researcher through interviews with the participants' teachers. The interviews followed the format of the Problem Identification Interview according to Kratochwill and Bergan (1990).

Both frequency and duration of the defined behaviors were measured. To determine frequency, each time a behavior occurred, a tally mark was placed in the appropriate column on the observation form. Duration was determined by timing how long the behavior lasted and was recorded by marking the data collection sheet when the occurrence of the behavior was first observed and timed until the behavior disappeared. At the termination of the behavior, another mark was made on the sheet. The spaces on the sheet were colored in from the onset of the behavior to the termination of the behavior. By summing those times between onset and termination for both before exercise and after exercise, the duration of the behavior was determined. These tally marks that occurred before riding the cycle were added up and used as pretest results.

They were compared with the total number of tally marks that occurred after riding the cycle, the posttest results. Because the sessions were videotaped, the duration of the behavior could also be observed both before and after the exercise bout. Then the means of pretest and posttests were compared for both frequency and duration.

The research assistants were trained by observing videotapes of children in a simulated classroom setting of two 20-minute sessions and recording the frequency and duration of specific behaviors throughout that 20-minute time period. This was done in the presence of the researcher and recording the data between two observers was practiced. Acceptable agreement is usually 80% or higher (Lavay et al., 2006).

Observers watched the 20-minute video of the participants. Any discrepancies of behavior identification were discussed until there was at least 80% agreement for the identification of specific behaviors (Maus, 2006). Then interrater reliability was determined by having the two research assistants who were scoring the classroom behaviors observe the same participant and record the data. The observers would meet every 3 weeks to go through this process with new participants that were to be viewed. Comparisons of the data were used to determine interrater reliability. However, inter-rater reliability did not meet the standard of 80% due to missing data and scoring discrepancies between the scorers.

Several lessons were learned from the pilot study that were either incorporated into or eliminated from this research project. The first and most vital factor was the discrepancy that was found between the Entertrainer's heart rate zones and the heart rate zones of the Polar Heart Rate Monitor. The Entertrainer would turn the television on and off at a different heart rate zone than the zone that was recorded on the heart rate monitor.

The heart rate that the Entertrainer needed to turn the television on was usually higher than the calculated heart rate for each participant. It was unclear what formula was used to determine THRZ and exercise levels using the Entertrainer. Therefore, there were discrepancies in the data of how long each participant pedaled in their actual THRZ. Some of these discrepancies were somewhat large. According to the data of the Entertrainer, some participants would pedal in their THRZ for 10 plus minutes. However, the heart rate that was recorded on the heart rate monitors may show that they pedaled for only a fraction of that time in their THRZ. It was concluded that the Entertrainer would not be used as the mode to turn the television on and off in the research study. Instead it was determined that this could be done more reliably using a research assistant sitting next to the participant to manually turn the television on or off.

Another key point learned from the pilot study is that more data points needed to be collected. Statistical significance for the split-middle technique could not be determined if there were fewer than five data points. Therefore, the testing sessions for each treatment needed to be longer to account for more exercise bouts.

Another observation from the pilot study was that it was unclear as to whether riding a cycle had any effect on reducing disruptive behaviors in the classroom. A minimum amount of disruptive behavior occurred and there was no difference in the amount of disruptive behaviors before the exercise bout and after the exercise bout. The participants that were chosen for the pilot study were higher functioning and exhibited very few disruptive behaviors. As a consequence, the analysis of disruptive behaviors was deleted from the study.

An additional factor that led to limited information being collected on the relationship between pedaling and disruptive behavior frequency was the fact that the duration of each bout of exercise that participants rode the bicycle was varied and small. Some exercise sessions were under 1 minute in duration. High functioning, well-behaved children, pedaling times of short duration, and a wide variety of pedaling times were assumed to lead to the lack of ability to detect a reduction in disruptive behaviors in the classroom after riding the cycle. Therefore, disruptive behaviors before and after exercise were not collected for the actual research study.

A final modification was to eliminate the baseline phase and have only two intervention phases. This was due to the fact that the focus of this research was to determine changes in trends between the contingent reinforcement phase and the delayed reinforcement phase. Comparisons of the baseline phase with both treatment phases would not have provided information that would be vital to answering the research question of this study.

Present Research Study

Study Site

The present study took place at the Carmen B. Pingree Center for Children with Autism in Salt Lake City, Utah. This Center is a private school specializing in educating children with Autism Spectrum Disorders from preschool through the secondary grades in an 11-month program.

There were approximately 120 children who attended this center at the time of the research study: 50 preschool children ages 3-5 and 70 elementary children (ages 6-12). There was an average of 10 to 12 children in each class. Applied Behavior Analysis is the primary approach used at this center.

Participants

The present study was reviewed and approved by the Institutional Review Boards from both the University of Utah and the Utah Department of Human Services. Ten participants who were selected by their teachers to be higher functioning were asked to participate in this study. These participants were selected nonrandomly from a homogenous sample. The 10 participants ranged in age from 6 -11 years. One participant elected to leave the study. Of the remaining 9 participants, there were a total of 7 males and 2 females. More male participants were available due to the fact that autism is four times more prevalent in boys than in girls (CDC, 2010a). Table 1 describes the participants in more detail. The parent(s) or guardian(s) of the children gave permission to have their children participate through a signed Parental Permission Document (see Appendix B).

Participants were excluded from the present study if they did not meet all of the following inclusion criteria:

1. Be between the ages of 6 and 12 years of age with a height of at least 36 inches. This minimum height was required for the participant to fit on a recumbent cycle properly and safely.
2. Be diagnosed as having some form of autism as per the criteria from the DSM-IV (American Psychiatric Association, 2000) or the ICD-10 (World Health Organization, 1993). The participant must show:
    a. impairment in social situations such as marked deficiencies in nonverbal behaviors (eye to eye gaze, facial expression, etc.);
    b. communication delays, possibly being nonverbal or unable to

Table 1. Demographics of all 9 participants that completed the study.

Participant	Sex	Age	Height	Weight	THR @ 40% -59%	O of T[a]	BMI
Participant 1	M	8 yrs 1 mos	52 ½ in	73.0 lbs	123-151	D[b]/C[c]	18.60
Participant 2	M	8 yrs 9 mos	50 ¼ in	48.0 lbs	138-161	C/D	13.36
Participant 3	M	10 yrs 4 mos	56 ¼ in	129.4 lbs	136-159	D/C	28.75
Participant 4	M	11 yrs 3 mos	57 in	70.6 lbs	134-157	D/C	15.30
Participant 5	F	9 yrs 6 mos	51 ¼ in	65.0 lbs	136-163	C/D	17.40
Participant 6	M	10 yrs 4 mos	62 ¾ in	108.4 lbs	135-158	C/D	19.30
Participant 7	F	7 yrs 7 mos	52 in	72.4 lbs	124-152	C/D	18.80
Participant 8	M	6 yrs 9 mos	52 ½ in	107.8 lbs	150-170	D/C	27.76
Participant 9	M	7 yrs 10 mos	50 ¾ in	65.2 lbs	133-158	C/D	17.80

[a] Order of Treatment
[b] Delayed
[c] Contingent

maintain conversation with others, repetitive language; and,

c. show some level of stereotypic behavior (self-stimulation, self-injurious behaviors; harm to self, others, or equipment).

3. Be at a certain developmental level to be able to understand and follow simple commands and instructions for the protocol. If they were not at a sufficient development level, they may have had difficulty with commands and instructions in the protocol of the present study (Mandelbaum et al., 2006). This development level was determined by the classroom teacher.

4. Be able to attend to a task long enough to ride a stationary recumbent cycle for at least 5 minutes. This was determined by the teacher of the participant through classroom observations and was tested by the researcher on the first day of the study.

5. Be free from any adverse health conditions such as cardiovascular or musculoskeletal issues that would impair their ability to ride a cycle at

moderate intensities safely or effectively.

Instrumentation

The following components were used in this study: A LeMond Fitness G-force RT recumbent stationary cycle (LeMond Fitness, Inc., Woodinville, WA). This particular recumbent stationary cycle was chosen due to the fact that it was a safer model with a more comfortable seat than an upright cycle. It was also easier for the participants to watch the television with their back being supported. A Polar E600 heart rate strap and wrist receiver (Polar Electro, Inc., Kempele FIN), a television monitor, and a DVD player were also used. In addition, a catalog of DVDs was provided for viewing.

The room in which the study took place was a conference room with no windows so that participants were isolated from outside distractions. The researcher, one to three research assistants, and the classroom teacher or teaching assistant accompanied the participant in the testing room.

Heart Rate

Heart rate (HR) was used to determine work intensity throughout the entire study while riding the stationary recumbent cycle. HR was measured using telemetry via a Polar E 600 heart rate monitor that has been validated for use with children (Sirard & Pate, 2001) and has been shown to be reliable for this population (Goran & Treuth, 2001).

THRZ was determined based on recommendations by the American College of Sport Medicine (ACSM) that moderate-intensity physical activity is performed at approximately 40%-59% of maximal heart rate (U. S. Department of Health and Human

Services, 2008). Other literature sets the high end of the threshold at 75% (Ridgers & Stratton, 2005; Stratton et al., 2007) but for the purposes of this study and in order to avoid overestimation of the THRZ, the high end of the threshold was set at 59% of maximal heart rate.

Researchers have determined that 50% of your maximum heart rate is the equivalent of walking briskly, which is moderate intensity (Armstrong & Welsman, 1997; Ridgers et al., 2005). It has been noted in the literature that approximately 75% of maximum heart rate is equivalent to more vigorous physical activity such as running (Payne, & Morrow, 1993; Stratton, 2000; Stratton et al., 2007). However, these cut points may be too high for this population. For this reason, 40% and 59% of maximum heart rate were the cut off points selected as the THRZ for this study.

To calculate THRZ for each participant, the heart rate reserve (HRR) method was used. The HRR method is the difference between the age-predicted maximal HR (220-age) and the resting heart rate (RHR). The lower limit of the THRZ is calculated as (HRR x 0.40) + RHR, and the upper limit of the THRZ is calculated as (HRR x 0.59) + RHR (ACSM, 2006).

This formula may have a tendency to overpredict HR in children because there is not a linear relationship between age and maximum heart rate in children (Gilbert, 2005). However, according to Stratton (1996) this is an acceptable method for setting HR thresholds in children. Several studies in the literature have used this formula to determine maximum HR and THRZ (Ridgers, & Stratton, 2005; Scruggs, et al., 2005; Scruggs et al., 2003; Stratton, 2000; Stratton et al., 2007).

Each participant's resting heart rate (RHR) needed to be determined. In order to calculate RHR, each participant sat for a 5-minute period and watched a video while wearing a heart rate monitor. With the assistance of a Pingree staff member, the participant was fitted with the heart rate monitor. The participant's resting heart rate (RHR) was determined by averaging the five lowest recorded heart rate values over a 5-minute period at the beginning of the first session before any data were collected, as recommended by Janz (2002) and Ridgers and Stratton (2005). The heart rate monitor was programmed to record heart rate every 5 seconds for this part of the study. From this resting heart rate, a THRZ was calculated using the aforementioned heart rate reserve method (ACSM, 2006). To help the participants sit still, they were allowed to watch a video during the recording of the heart rate. This THRZ was used across both treatment phases of the study.

Procedures on the Cycle

On the first day before data collection started, qualifying participants reported to the exercise room where the equipment was set up. They were briefed on what they would be doing on the stationary recumbent cycle. Each participant had an opportunity to sit on the cycle and pedal it. They were shown the television and where it would be to watch it under both conditions. They were also shown the HR monitor and how it would be placed on them. All concerns and questions were addressed at this time. The participants had the Assent to Participate in the Study Form read and explained to them (see Appendix C) to take part in the research. They were briefed on the procedures and instructed that they could terminate the study at any time. They were then asked to sign the assent if they were willing to participate in the research.

Participants returned for a second day before the actual study began to have their RHR and THRZ determined. The level that each participant would pedal to reach his or her target heart rate was also established on this day. The intensity levels on the cycle started at level 1 and went to level 20. The cycle was set at level 1. The participant pedaled for a 5-minute period. If the target heart rate was reached during that level, then the participant was asked to stop. If their target heart rate was not reached in that 5-minute period, then the research assistant would increase the intensity to level 2 and the participant would pedal another 3 minutes. This was a continuous process without any rest period between level changes. This procedure would continue until target heart rate was reached during that particular level on the cycle. That level would then be the setting on the cycle throughout each treatment phase.

For demographic information, height and weight of each participant was also taken at this time. The demographic and descriptive information for each participant is represented in Table 1.

Each child participated in both conditions, thus possibly creating an interaction of treatments. This possible interaction of treatments is a major threat to internal validity to this single subject design. In other words, the participant may become familiar with the treatment procedure when the treatment is given multiple times and the procedure becomes easier. Therefore, the change in results may be mistaken for a treatment effect (Cook & Campbell, 1979; Shadish, Cook, & Campbell, 2002).

To be able to control for a potential learning or order effect, a cross over method of assignment of treatments was implemented. Therefore, the order in which the participants received contingent and delayed reinforcement was randomly assigned. One participant received contingent reinforcement first then delayed reinforcement and another received the opposite. Table 1 also signified the treatment order for each participant.

Each participant came to the exercise room with the teacher or teacher's aide and the heart rate monitor was placed on the participant. The participant chose 1 DVD from a menu of 15 DVDs to view for that exercise session for both the contingent reinforcement phase and the delayed reinforcement phase. The DVDs were a combination of animated films from Disney and Pixar. The majority of the time, the children picked the same DVD to watch for each exercise bout. However, on occasion, the participant would choose a different DVD. They always chose a DVD with which they were familiar, had seen before, or one that is similar to a DVD they had seen in the past.

For the delayed reinforcement phase, it was explained to each participant that he/she would be rewarded with watching a DVD of their choice for the same number of minutes that he/she pedaled in their THRZ. For example, on Day 1, if the participant pedaled the cycle for 15 minutes in his/her assigned THRZ, then he/she was allowed to subsequently watch a DVD of their choice for 15 minutes. If they did not pedal in their THRZ they were told that they would be allowed to watch television for a 1-minute limit after the pedaling bout was complete. This treatment phase lasted between 5-8 days.

Some days were missed due to school activities and absences of the children. Therefore, some phases did not have consecutive days pedaling by the participant. However, each participant needed a minimum of 5 days in each phase to ride the recumbent stationary cycle for a total of at least 10 treatment sessions throughout the entire study.

For the contingent reinforcement phase, it was explained to each participant that he/she would be rewarded with watching a DVD of their choice as long as he/she pedaled the cycle in their THRZ. During this phase a research assistant was assigned to watch the heart rate monitor of each participant. If the participant entered into their THRZ, then the research assistant would turn on the television using a remote control. If the participant dropped below their THRZ, then the research assistant would immediately turn the television off. The research assistant was positioned next to the participant on the cycle holding the remote out of site of the participant.

Verbal encouragement was given to all participants across both treatments. The verbal encouragement was reserved for times when the participant stopped pedaling. Only statements such as “keep pedaling,” “keep going” were used when the participant slowed pedaling or stopped pedaling.

To ensure that each participant would become accustomed to the treatment procedure and not become physically overworked at the onset, each participant would not be allowed to pedal past the pedal limit that was set. The first day, the limit was set at a maximum of 15 minutes. The second day, the recommended maximum time of pedaling was increased to 20 minutes. Finally, on the third day of the treatment phase, the maximum time participants could pedal increased to 60 minutes. From that time forward throughout the remainder of the study, 60 minutes was the maximum time that each participant would be allowed to pedal. It should be noted that they were not required to pedal for the complete 60 minutes, just encouraged. If the participants wanted to they could sit on the bicycle for the full time allotted even if they did not pedal.

Design and Statistical Analysis

This study was a single subject, alternating-treatment AB design. Single subject designs have been shown to be an appropriate design to use in research for individuals with disabilities (Horner et al., 2005). Single subject designs focus on the individual and what changes that individual presents in the research. Assumptions such as a normal distribution that are found in parametric statistics are not required. In addition, single subject research can single out responders and nonresponders of a group more easily to give more detailed information to the researcher. For example, if any data are missing because the participant has not taken part in a testing session, the researcher can determine when the data were missed and whether the circumstances they missed were influential to the outcome (fear of test, sickness, etc.). Finally, single subject designs are a cost effective way to collect and analyze data for educational and behavioral interventions because they require fewer participants and may require fewer resources, namely, time, surveys, or research help (Horner et al., 2005). These designs are particularly appropriate for this population in that children with autism are very diverse. No two individuals are the same. It was beneficial also for the simple fact that there was a limited pool of participants from which to choose.

To analyze the data for this research study, the split-middle technique was used. This technique was used to test for changes in behavior over different treatment phases (Kazdin, 1982). The rate of change of a behavior is examined over time to determine if a trend is present. The split-middle technique not only examines participant’s present performance but also allows one to possibly predict future performance with this same participant or possibly look at reaching a particular objective. This technique also allows one to examine any particular trend within a phase and make comparisons to other phases. Using rate of behavior (frequency/time) is considered the best measure for the split-middle technique because no limit can be put on the slope of the trend. For this study the split-middle technique was used to analyze the trends of duration time pedaled in the THRZ across different treatment phases. By describing the rate of behavior change, or for the purposes of this study, duration of time pedaled in the THRZ, the split-middle technique can show the trend of a participant's behavior across treatment phases and determine if there are differences in those trends (Barlow & Hersen, 1984).

The first step in the split-middle technique is to plot the data from a particular phase on a scatter-plot (see Figure 1).

From these data points, a trend or celeration line is created to reflect the direction and rate of change of a behavior over time in a given phase. This process has several steps that will be illustrated in Figure 2.

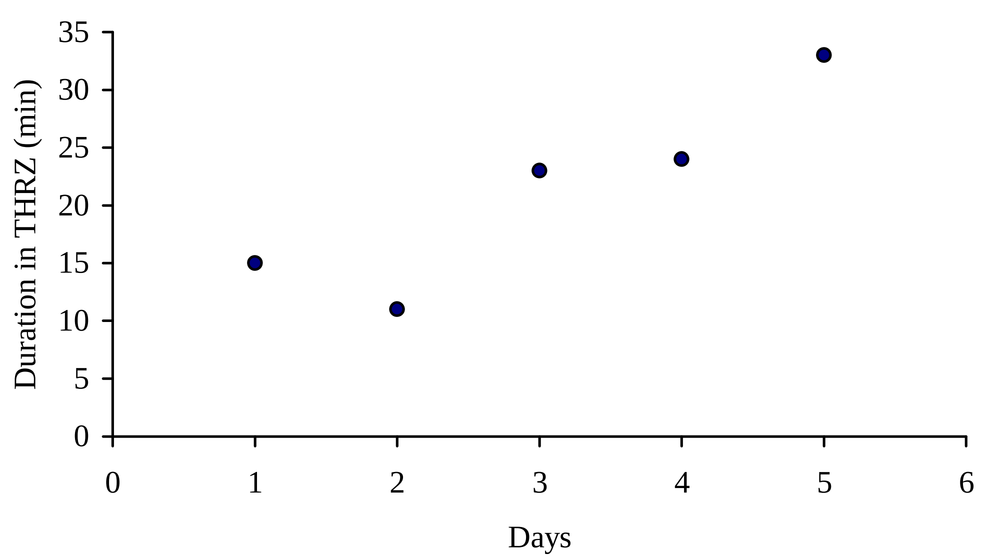

Figure 1. Sample data set to reflect data points plotted on a scatter-plot.

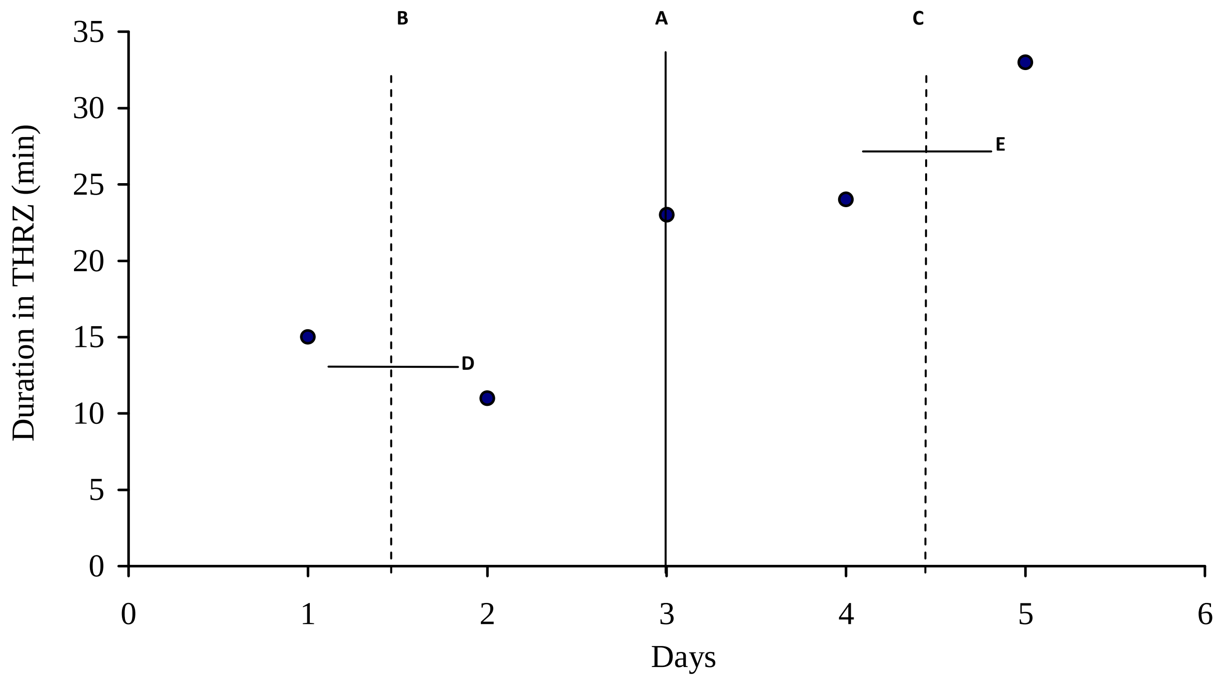

Figure 2. Reflects celeration line construction by dividing the graph into halves (solid vertical line, A), quarters (dashed vertical lines, B&C) at median points on the graph and 2 horizontal lines (D&E).

The first step is to divide the graph into halves. This is done by drawing a line through the median data point of the graph (A). If there are an even number of data points, the line dividing the graph is drawn between the two most center points. The idea is to have an equal number of data points on both halves of the graph.

The second step involves dividing each of the halves in half once more as signified by the dotted lines (B & C). After dividing the graph into quarters, there should be an equal number of data points in each quarter. It is important to note that even though there are four quadrants in this graph, it is only the two halves that are divided by line A that are important in this stage.

The third step in determining the celeration line is to establish what the trend of time pedaled in the THRZ is for both the first and second halves of the treatment phase.

This can be accomplished by finding the median points for the dependent measure (duration pedaled in THRZ). Data points are then counted from the lowest data point upwards to the highest data point. In this example in Figure 2, the median point, marked on line B, is 12.5 in the first half using Day 1 (15) and Day 2 (10). The median point for the second half was approximately 28.5 using Day 4 (24) and Day 5 (33). Horizontal lines (D & E) are then drawn through that median point and connected with the vertical dotted lines (B & C). If there were an even number of data points, the lines are drawn in between the two centermost points.

The final step is to generate a trend line that will "split" all of the data points, as shown in Figure 3. A trend line (F) is drawn through points H & I in Figure 3. This line should have same number of data points fall on or below the line that fall on or above the line. If there are an unequal number of data points above and below the trend line, an adjusted trend line may be drawn to correct for that. The solid line (F) in Figure 3 is the actual trend line. The dotted line (G) is an adjusted trend line to situate 50% of the data

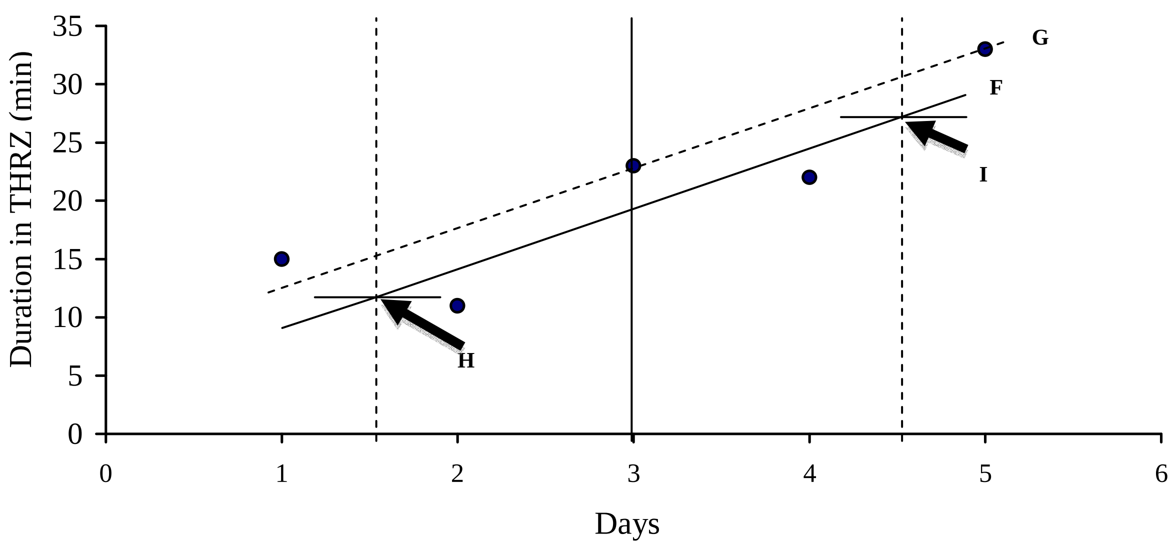

Figure 3. A solid line (F) is drawn through points H & I in each half. The dashed line (G) is the adjusted line to fit the same number of data points below, above, or on the trend line.

The adjusted trend line (G) can be moved up or down from the original trend line drawn (F).

The split-middle technique provides a way to look at trends that are occurring over time. Graphical explanation can be an effective way to express data using this technique. In addition, the rate of change of a behavior and the level of the behavior may be expressed numerically. The rate of behavior change is indicated with a celeration line on a scatter plot graph. The direction of the celeration line may follow a positive direction meaning an increase in the occurrence of a behavior or it may follow a negative direction showing a decrease in the occurrence of the behavior. The rate of behavior change (slope of the line) in a single phase can be calculated by recording the pedal time on the first day and the pedal time on the last day. The smaller number is then divided into the larger number to determine a numerical value for the slope. For example, the graph above Day 1 has a value of 15 min and Day 5 has a value of 33 min. The score 33 is then divided by 15 signifying a slope of 2.20. This celeration line follows a positive direction (accelerating) signifying that the rate of response is 2.20 times greater at the end of the week than at the beginning of the week, demonstrating that the trend is increasing. It can be predicted that the behavior will likely continue to increase over time.

Data points were plotted on a graph that is a $\log_{10}$ scale. By using a $\log_{10}$ scale, the data are better represented (Barlow & Hersen, 1984). With a $\log_{10}$ graph, zeros are not represented. However, zeros are still important and needed in order to calculate statistical significance. Therefore, the same formula would be used. For example, assume hypothetically that two of the data points in Figure 4 in the contingent reinforcement phase are 0. In other words, the participant pedaled the cycle those days

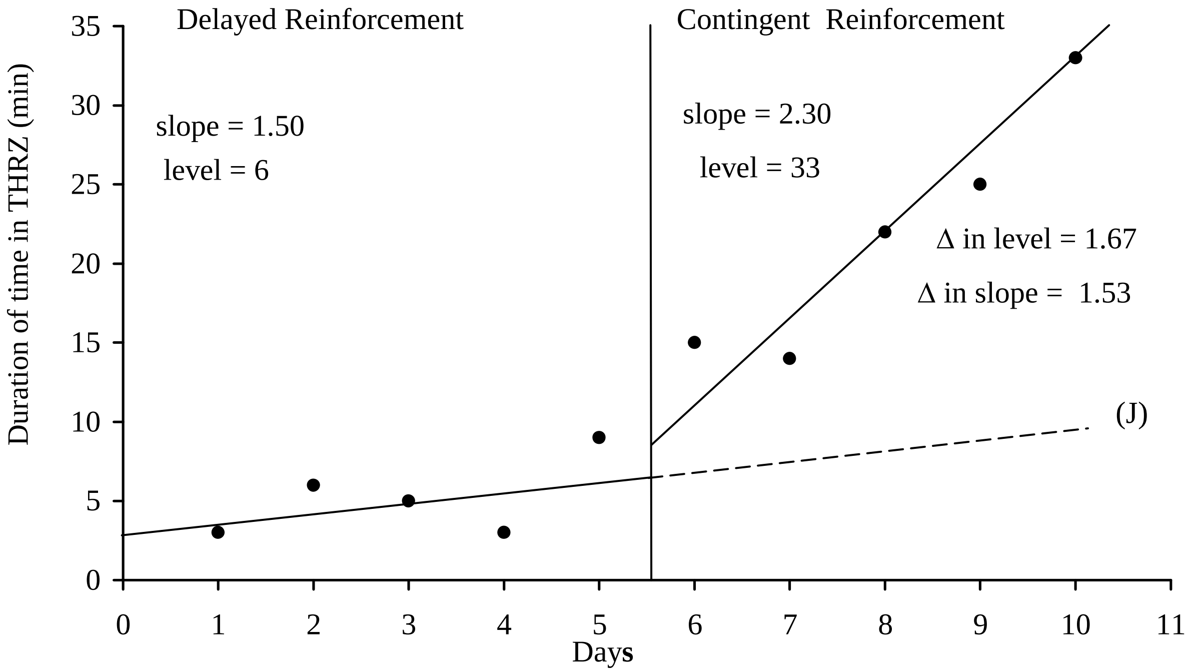

Figure 4. Data for both delayed reinforcement and contingent reinforcement treatments with solid celeration lines. The extension of the delayed reinforcement celeration line is represented by the dashed line. Individual slope and level as well as change in level and slope across phases are shown.

but not at an intensity to be in their THRZ. This information is still important. The calculation for this hypothetical participant would be as follows: $(5/3)0.5^5 = 0.052$, thus not statistically significant.

The level of the celeration line like the slope of the trend line gives us an idea of an individual's performance across a treatment phase. The level of the celeration line can also be calculated. The level of the celeration line is determined by examining where the celeration line passes through the data point for the final day of that phase. For example, in Figure 3, the celeration line passes through the last data point with a numerical value of 30 minutes. Therefore, the level of the celeration line for that individual for that particular phase is 30.

Once celeration lines are drawn for the different treatment phases, it is possible to observe changes between the trends across those different treatment phases. This can be observed in Figure 4 by examining the changes in the slopes (1.5 and 2.3) and changes in the levels of the celeration lines (6 and 33) between the two phases.

To determine if there is a change in slope of the celeration line between the first phase and the second phase, divide the larger numerical value for the slope of the celeration line in the contingent reinforcement phase by the smaller numerical value for the slope of the celeration line in the delayed reinforcement phase. The calculation from Figure 4 is as follows: 2.30/1.50 = 1.53. Therefore, the change in slope of the celeration line in the contingent reinforcement phase is 1.53 times greater than in the delayed reinforcement phase.

Calculating the changes in level of the celeration line is similar. To determine if there is a change in level of the celeration line between the first phase and the second phase, the last data point of the first phase and the first data point of the second phase are used. The larger level number is divided by the smaller level number to provide the change in level between delayed reinforcement and contingent reinforcement. From Figure 4, it would be calculated by dividing the last data point (9) in the delayed reinforcement phase (Day 5) into the first data point (15) of the contingent reinforcement phase (Day 6), 15/9 = 1.67. Thus the level of the celeration line of the contingent reinforcement phase is 1.67 times greater than the level of the celeration line in the delayed reinforcement phase. By calculating and recording changes of both slope and level of the celeration line across different phases, change in trends across treatment phases can be observed.

It is important to make note that the split-middle technique is primarily designed to look at changes in trends of a participant over time more than looking at statistical differences; however, statistical significance can be calculated. The null hypothesis is that there will be no change in behavior across different treatment phases. If the null hypothesis is accepted, then there should be no difference in the slope of the celeration line and its level between the delayed reinforcement phase and the contingent reinforcement phase.

To determine statistical significance, the celeration line in the delayed reinforcement phase is continued into the contingent reinforcement phase signified by the dashed line (J) in Figure 4. The assumption is that if the null hypothesis is accepted, the probability of a data point in the contingent reinforcement phase falling above the projected celeration line from the delayed reinforcement phase is 50% given the null hypothesis of no change across phases. To determine if the number of data points that are above (or below) the projected slope is of sufficiently low probability to reject the null hypothesis, a binomial equation can be used (Barlow & Hersen, 1984; Kazdin, 1982).

In Figure 4, there are 5 data points (n = 5) in the delayed reinforcement phase and 5 data points (n = 5) in the contingent reinforcement phase. To determine statistical significance that the trend of pedaling in the THRZ is more positive in the contingent reinforcement phase than the trend of pedaling in the THRZ in the delayed reinforcement phase, data points in the contingent reinforcement phase are counted above and below to the dashed line (J).

The formula is: $f(x) = (n/x)\ p^x q^{n-x}$ or simply $(n/x)p^n$

n = the number of total data points in phase B
x = the number of data points above (or below) the projected slope
p = q = .5 by definition of the split-middle slope
p and q = the probability of data points appearing above (or below) the slope given the null hypothesis.

In Figure 4, all 5 data points in the contingent reinforcement phase fall above the dashed line (J). Therefore, the binomial equation is calculated to determine the probability of obtaining all 5 data points above the dashed line, $({}^{5}{}_{5})½^{5}$, which is 0.5^5 = 0.031. Therefore, the null hypothesis can be rejected; the trend of pedaling in the THRZ in the contingent reinforcement phase is significantly different from the trend of pedaling in the THRZ in the delayed reinforcement phase.

If several data points fall below the line and there are less than 5 data points that fall above the line, the formula needs to be adjusted. For example, assume hypothetically that two of the data points in the contingent reinforcement phase fall below the dashed line (see Figure 5). The calculation for this hypothetical participant would be as follows: $({}^{5}{}_{2})0.5^{5}$ = 0.313, thus, not statistically significant.

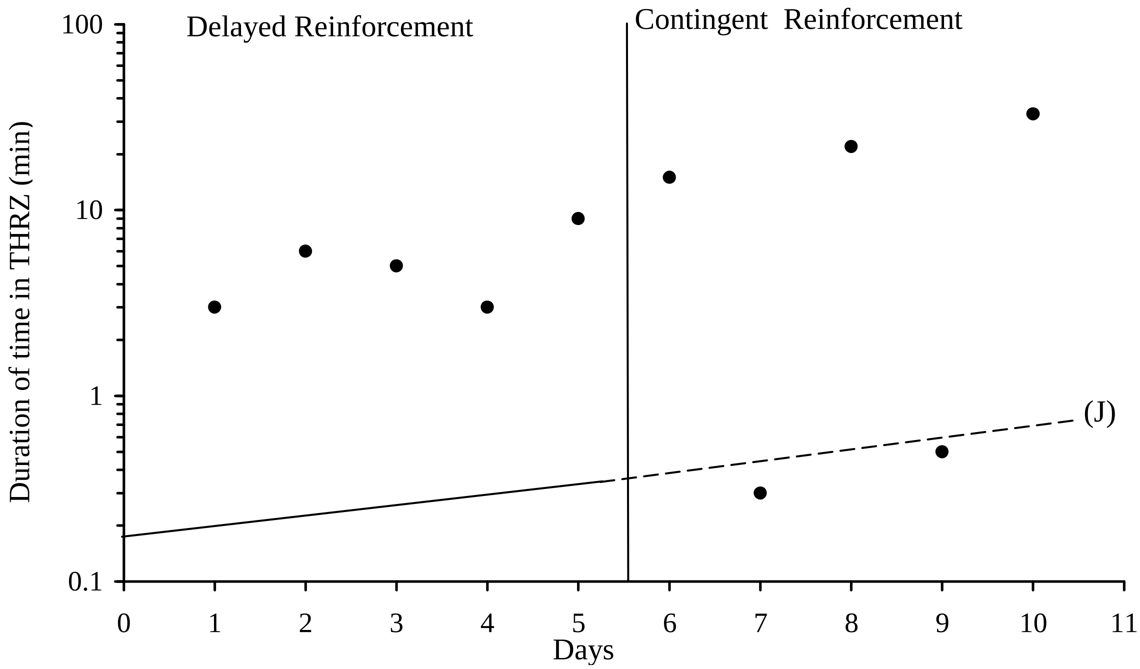

Figure 5. Data for both delayed reinforcement and contingent reinforcement treatments with solid celeration lines. The extension of the delayed reinforcement celeration line is represented by the dashed line. Day 7 and Day 9 represent data points that fall below the dashed line, thus making the differences between the delayed reinforcement phase and the contingent reinforcement phase not significant, p = 0.313.

CHAPTER 4

RESULTS AND DISCUSSION

Data of participants from Carmen B. Pingree Center for Children with Autism were analyzed through both visual and statistical analyses. The main focus of this research was to determine changes in pedaling time trends over the two treatment phases where different conditions were applied. Heart rate and total pedaling time were monitored and recorded. Visual analysis is presented through graphs that show trends for each participant. Both visual and statistical analyses for each participant's pedaling trend were calculated using the split-middle technique.

Due to the fact that most of these participants did not pedal for long durations of time in either phase, the change in level of the celeration lines between phases is reported on each of the graphs but not used as a comparison of the phases in the discussion.

Graphs for each participant signify which treatment they received first. For example, if the participants were randomly assigned to participate in the contingent reinforcement phase first, that would be the first half of the graph and the delayed reinforcement phase would be the second half of the graph. If the participant received the delayed reinforcement phase first, then the order of the treatment was delayed first and contingent second.

Participant 1

Participant 1 was a male who was 8 years and 1 month in age. The data trends by study phase are shown for Participant 1 in Figure 6. Participant 1 was randomly assigned to receive the delayed reinforcement phase first and the contingent reinforcement phase second.

During the delayed reinforcement phase, the slope of the celeration line was -3.70, signifying that the duration of pedaling on Day 8 was 3.70 times lower than on Day 1. Participant 1 reduced his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 1 to Day 8.

During the contingent reinforcement phase, the slope of the celeration line was -1.73, signifying that the duration of pedaling on Day 15 was 1.73 times lower than on Day 9. Participant 1 reduced his time spent pedaling in his THRZ across the contingent reinforcement phase from Day 9 to Day 15.

There was a negative trend in his pedaling in his THRZ during both the delayed reinforcement phase and the contingent reinforcement phase. However, the trend was less negative during the contingent reinforcement phase compared to the delayed reinforcement phase.

Comparing the contingent reinforcement phase to the delayed reinforcement phase, there was a change in slope between the two phases of 2.13. Therefore, the trend of pedaling for Participant 1 in his THRZ during the contingent reinforcement phase was 2.13 times greater than during the delayed reinforcement. This signifies that there was a change across phases for the trend of pedaling in his THRZ.

In Figure 6, all 7 of the data points in the contingent reinforcement phase are

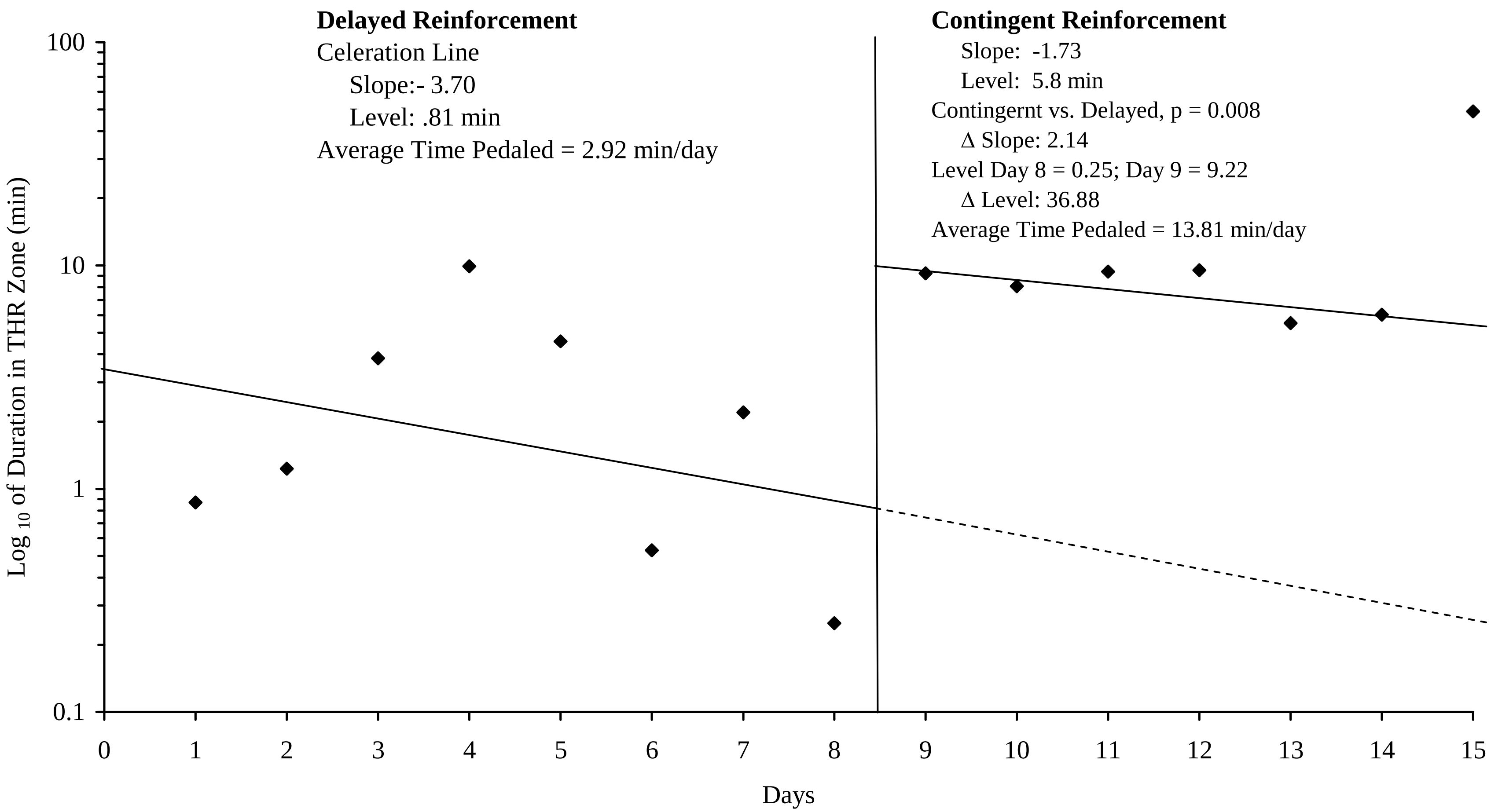

Figure 6: Participant 1 comparison between the delayed reinforcement phase and the contingent reinforcement phase with a significant difference (p = 0.008) detected between the two phase.

above the projected slope from the delayed reinforcement phase. Therefore, the binomial equation is calculated to determine the probability of obtaining all 7 data points above the projected slope, $\binom{7}{7}\frac{1}{2}^7$, which is $0.5^7 = 0.008$. Therefore, the null hypothesis can be rejected. The trend of pedaling in the THRZ during the contingent reinforcement phase is significantly greater than the trend of pedaling in the THRZ during the delayed reinforcement phase.

Participant 1 spent an average of 2.92 minutes/day pedaling in his THRZ during the delayed reinforcement phase (see Table 2). By contrast, Participant 1 spent an average of 13.81 minutes/day pedaling in his THRZ during the contingent reinforcement phase.

Participant 2

Participant 2 was a male who was 8 years and 9 months in age. The data trends by study phase are shown for Participant 2 in Figure 7. Participant 2 was randomly assigned to the contingent reinforcement phase first and the delayed reinforcement phase second. During the contingent reinforcement phase, the slope of the celeration line was 1.20, signifying that the duration of pedaling on Day 7 was 1.20 times higher than on Day 1. Participant 2 increased his time spent pedaling in his THRZ across the contingent reinforcement phase from Day 1 to Day 7.

During the delayed reinforcement phase, the slope of the celeration line was -1.64, signifying that the duration of pedaling on Day 12 was 1.64 times lower than on Day 8. Participant 2 reduced his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 8 to Day 12.

Table 2. Trends of pedal time, average time pedaled in THRZ, and ratio of average time pedaled in THRZ for contingent reinforcement phase and delayed reinforcement phase.

Participant	Contingent R+ Trend	Delayed R+ Trend	ATP in THRZ, Con. R+[a] (min/day)	ATP in THRZ, Del. R+[b] (min/day)	Average Time Ratio[c]	Sig.
P1	Neg.	Neg.	13.81	2.92	4.72	$p = 0.008$
P2	Pos.	Neg.	5.94	3.40	1.77	$p = 0.031$
P3	Pos.	Pos.	21.74	9.24	2.35	$p = 0.164$
P4	Pos.	Neg.	1.6	0.32	4.92	$p = 0.016$
P5	Neg.	Non-Det.[d]	2.07	0.03	66.38	$p = 0.004$
P6	Pos.	Neg.	45.35	9.02	5.03	$p = 0.008$
P7	Pos.	Neg.	2.82	0.92	3.05	$p = 0.004$
P8	Neg.	Neg.	0.62	2.41	3.88	$p = 0.093$
P9	Pos.	Pos.	4.58	1.62	2.82	$p = 0.031$

[a] Average time pedaled (ATP) in THRZ during the contingent reinforcement (R+) phase
[b] Average time pedaled (ATP) in THRZ during delayed reinforcement (R+) phase
[c] Ratio between average minutes/day pedaled in THRZ during Con R+ and average minutes/day pedaled in THRZ during Del R+
[d] Nondetectable

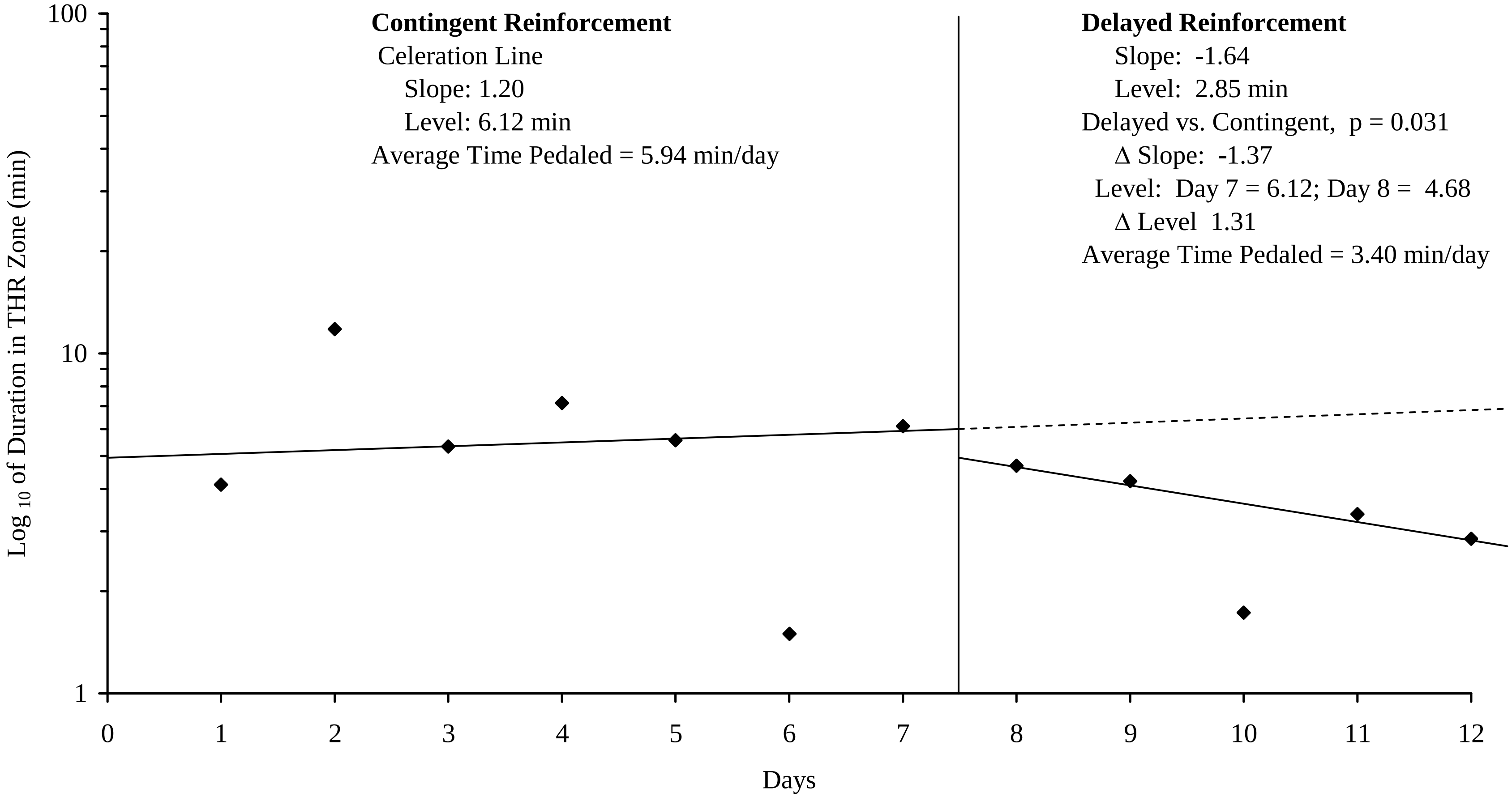

Figure 7: Participant 2 comparison between the contingent reinforcement phase and the delayed reinforcement phase with a significant difference (*p* = 0.031) detected between the two phases.

There was a positive trend of pedaling in his THRZ during the contingent reinforcement phase and a negative trend of pedaling in their THRZ during the delayed reinforcement phase.

Comparing the contingent reinforcement phase to the delayed reinforcement phase, there was a change in slope between the two phases of -1.37. Therefore, the trend of pedaling for Participant 2 in his THRZ during the contingent reinforcement phase was 1.37 times greater than during the delayed reinforcement phase. This signifies that there was a change across phases for the trend of pedaling in his THRZ.

In Figure 7, all 5 of the data points in the delayed reinforcement phase are below the projected slope from the contingent reinforcement phase. Therefore, the binomial equation is calculated to determine the probability of obtaining all 5 data points below the projected slope, $({}^{5}{}_{5})½^{5}$, which is $0.5^{5} = 0.031$. Therefore, the null hypothesis can be rejected. The trend of pedaling in the THRZ during the contingent reinforcement phase is significantly greater than the trend of pedaling in the THRZ during the delayed reinforcement phase.

Participant 2 spent an average of 5.94 minutes/day pedaling in his THRZ during the contingent reinforcement phase (see Table 2). By contrast, Participant 2 spent an average of 3.40 minutes/day pedaling in his THRZ each day during the delayed reinforcement phase.

Participant 3

Participant 3 was a male who was 10 years and 4 months in age. The data trends by study phase are shown for Participant 3 in Figure 8. Participant 3 was randomly assigned to the delayed reinforcement phase first and contingent reinforcement phase

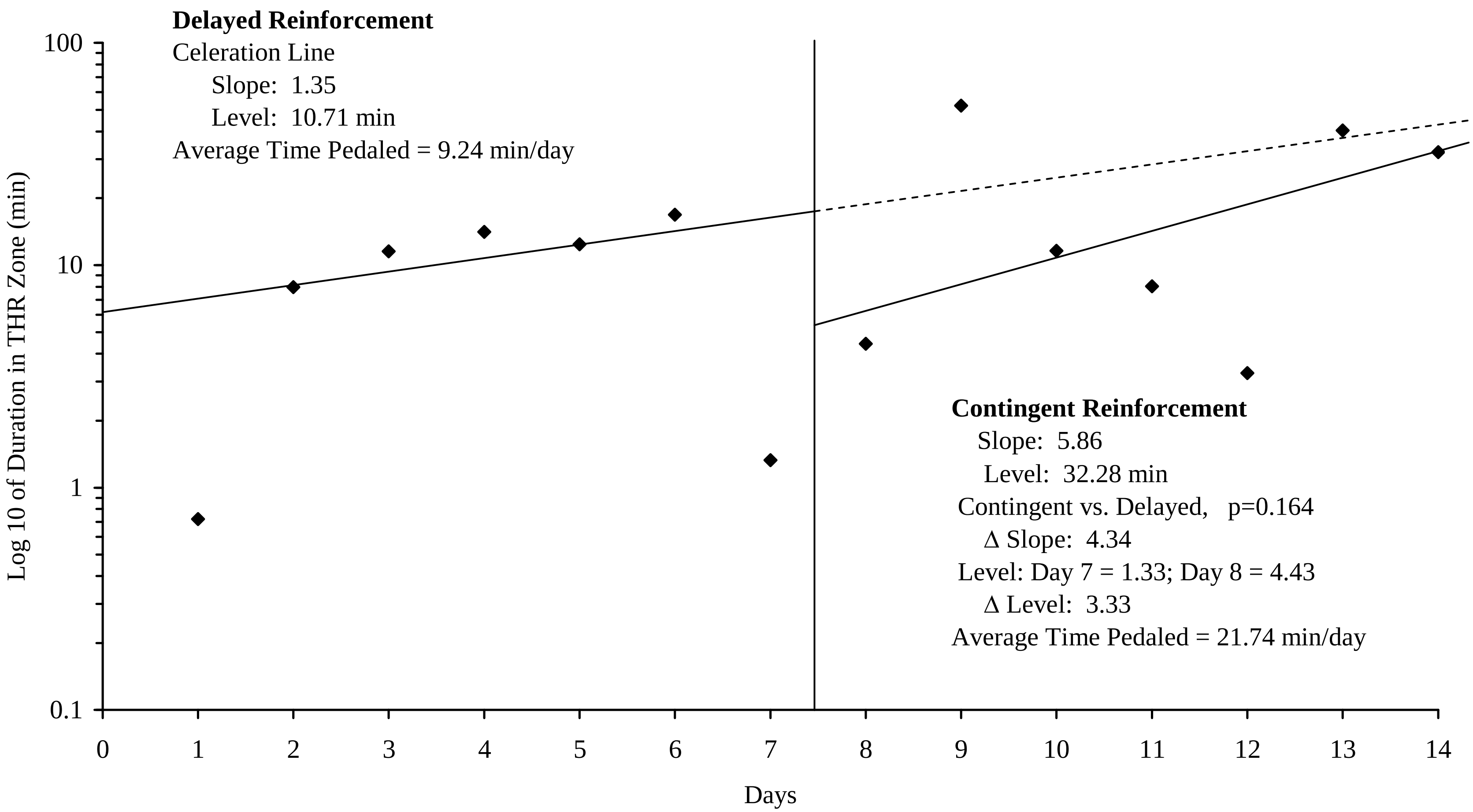

Figure 8: Participant 3 showed no significant difference between the two phases (*p* = 0.164) in total time pedaled in THRZ between the delayed reinforcement phase and the contingent reinforcement phase.

second.

During the delayed reinforcement phase, the slope of the celeration line was 1.35, signifying that the duration of pedaling on Day 7 was 1.35 times greater than on Day 1. Participant 3 increased his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 1 to Day 7.

During the contingent reinforcement phase, the slope of the celeration line was 5.86, signifying that the duration of pedaling on Day 14 was 5.86 times higher than on Day 8. Participant 3 increased his time spent pedaling in his THRZ across the contingent reinforcement phase from Day 8 to Day 14

There was positive trend of pedaling in his THRZ during both the contingent reinforcement phase and the delayed reinforcement phase with the contingent reinforcement phase having a more positive trend.

Comparing the contingent reinforcement phase to the delayed reinforcement phase, there was a change in slope between the two phases of 4.37. Therefore, the trend of pedaling for Participant 3 in his THRZ during the contingent reinforcement phase was 4.37 times greater than during the delayed reinforcement. This signifies that there was a change across phases for the trend of pedaling in his THRZ.

In Figure 8, 5 of the data points fall below and 2 data points fall above the projected slope in the contingent reinforcement phase. Therefore, the binomial equation is calculated to determine the probability of obtaining all 7 data points below the slope, $({}^{7}{}_{5})\tfrac{1}{2}^{7}$, which is $(21)\ (0.5)^{7} = 0.164$. The null hypothesis cannot be rejected and the trend of pedaling in the THRZ during the contingent reinforcement phase is not significantly different than the trend of pedaling in the THRZ during the delayed reinforcement phase.

However, only 2 of the 7 data points in the contingent reinforcement phase fall above the extended line from the delayed reinforcement phase. Therefore, a good indicator is looking at Figure 8 and it can be noted that there is a steeper slope during the contingent reinforcement, signifying that there was a greater trend in the contingent reinforcement phase than the delayed reinforcement phase.

Participant 3 pedaled an average of 9.24 minutes/day in his THRZ during the delayed reinforcement phase (see Table 2). By contrast, Participant 3 pedaled an average of 21.74 minutes/day in his THRZ during the contingent reinforcement phase.

Participant 4

Participant 4 was a male who was 11 years and 3 months in age. The data trends by study phase are shown for Participant 4 in Figure 9. Participant 4 was randomly assigned to the delayed reinforcement phase first and then contingent reinforcement phase second.

During the delayed reinforcement phase, the slope of the celeration line was -2.84, signifying the duration of pedaling on Day 8 was 2.84 times lower than on Day 1. Participant 4 reduced his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 1 to Day 7.

During the contingent reinforcement phase, the slope of the celeration line was 26.97, signifying the duration of pedaling on Day 14 was 26.97 times higher on Day 14 than on Day 9. Participant 4 increased his time spent pedaling in his THRZ across the contingent reinforcement phase from Day 9 to Day 14. There was a positive trend of pedaling in his THRZ in the contingent reinforcement phase and a negative trend of pedaling in his THRZ for the delayed reinforcement phase.

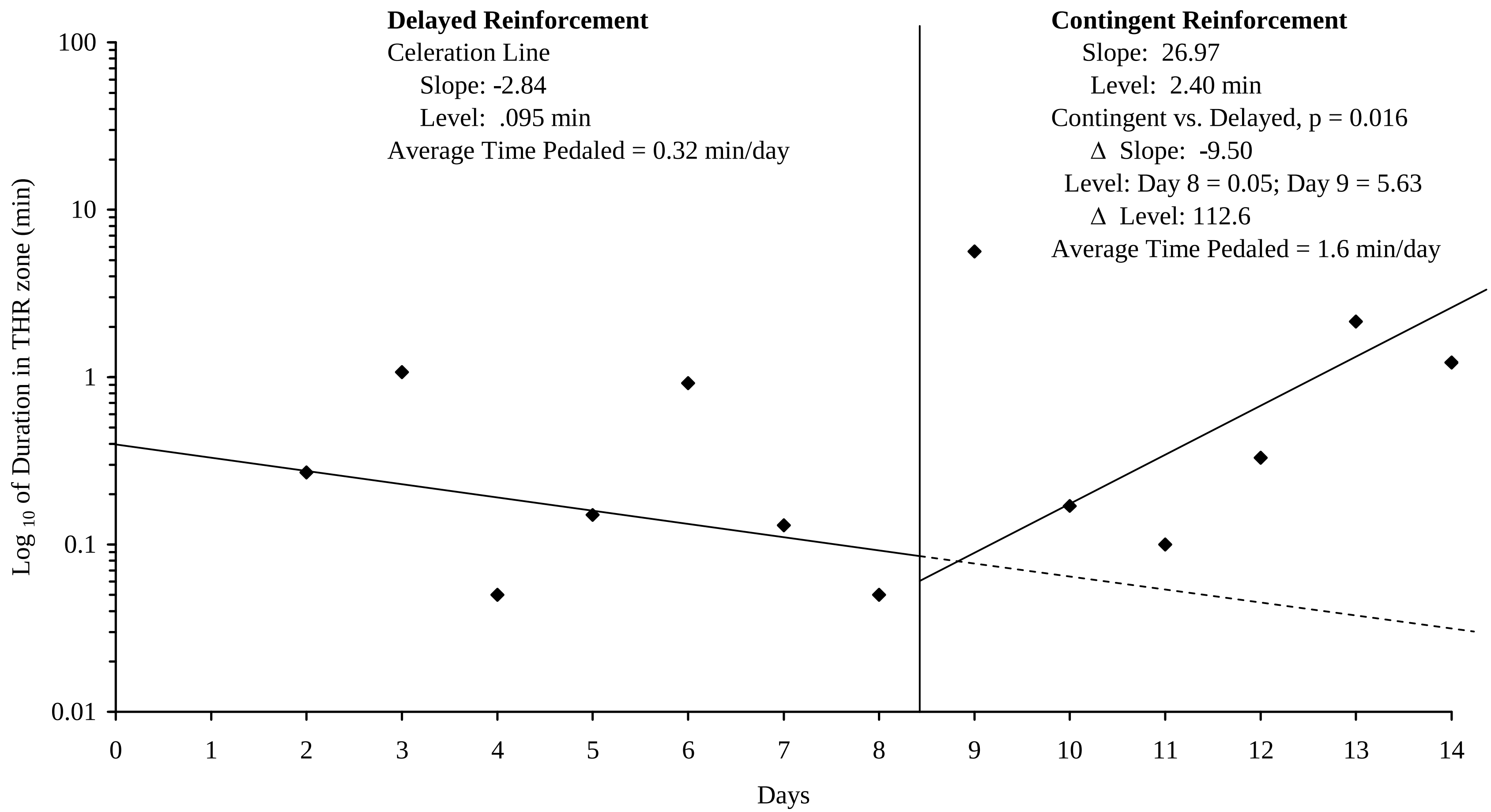

Figure 9: Participant 4 comparison between the delayed reinforcement phase and the contingent reinforcement phase with a significant (p = 0.016) difference between the two phases.

Comparing the contingent reinforcement phase to the delayed reinforcement phase, there was a change in slope between the two phases of -9.5. Therefore, the trend of pedaling for Participant 4 in his THRZ during the contingent reinforcement phase was 9.5 times greater during the delayed reinforcement. This signifies that there was a change across phases for the trend of pedaling in his THRZ.

In Figure 9, all 6 of the data points in the contingent reinforcement phase are above the projected slope from the delayed reinforcement phase. Therefore, the binomial equation is calculated to determine the probability of obtaining all 6 data points above the slope, $({}^{6}{}_{6})½^{6}$, which is $(0.5)^{6} = 0.016$. Therefore, the null hypothesis can be rejected. The trend of pedaling in the THRZ during the contingent reinforcement phase is significantly greater than the trend of pedaling in the THRZ during the delayed reinforcement phase.

Participant 4 spent an average of 0.32 minutes pedaling in his THRZ during the delayed reinforcement phase (see Table 2). By contrast, Participant 4 spent an average of 1.6 minutes/day pedaling in his THRZ in the contingent reinforcement phase.

Participant 5

Participant 5 was a female who was 9 years and 6 months in age. The data trends by study phase are shown for Participant 5 in Figure 10. Participant 5 was randomly assigned to the contingent reinforcement phase first and the delayed reinforcement phase second.

During the contingent reinforcement phase, the slope of the celeration line was -6.47, signifying that the duration of pedaling on Day 7 was 6.47 times lower than it was on Day 1. Participant 5 reduced her time spent pedaling in her THRZ across the

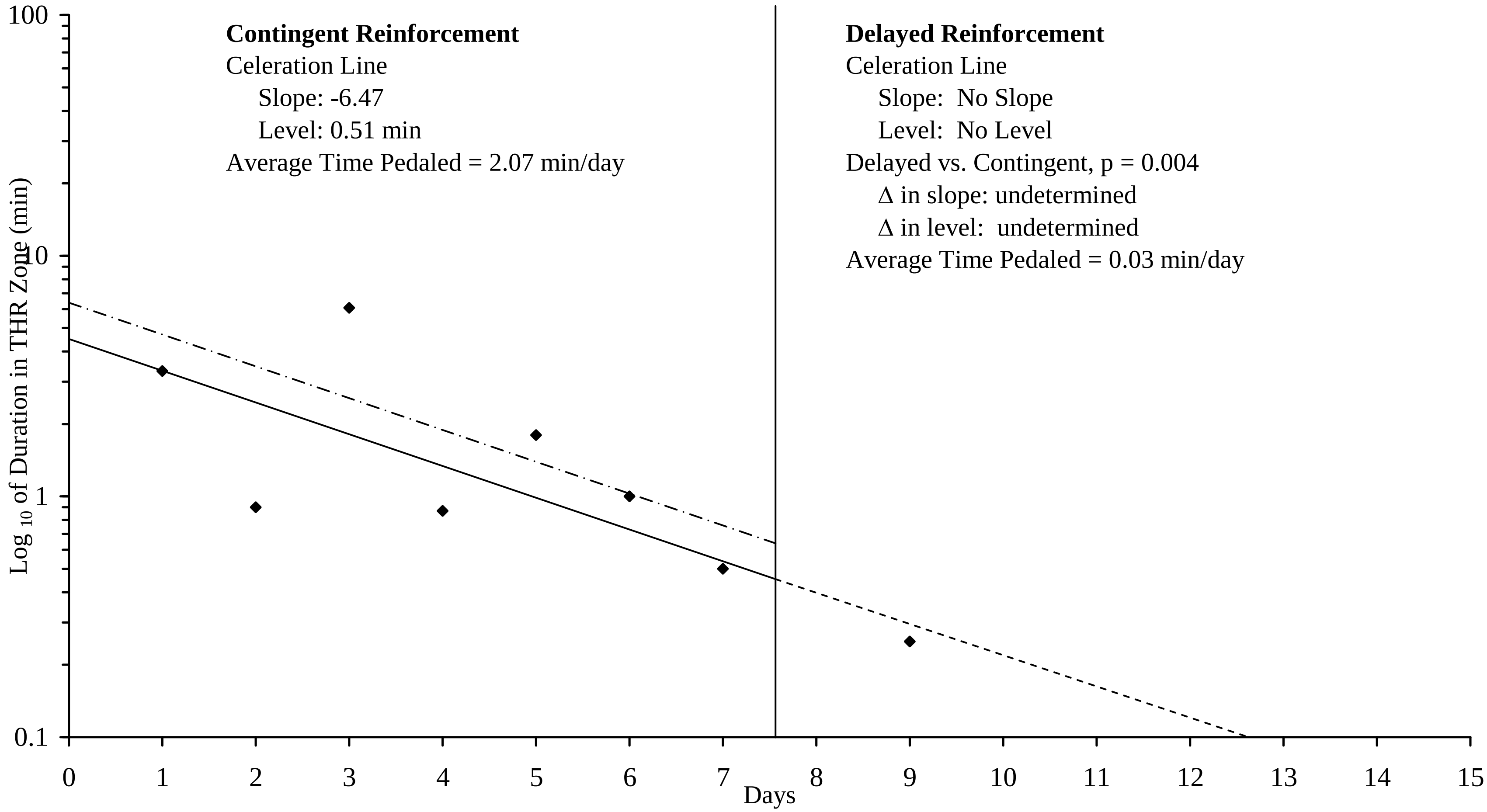

Figure 10: Participant 5 comparison between the contingent reinforcement phase and the delayed reinforcement phase with statistical significance (p = 0.004) between the two phases. The solid line in the contingent reinforcement phase is the adjusted celeration line and the broken line in the contingent reinforcement phase is the actual celeration line.

contingent reinforcement phase from Day1 to Day 7.

The time spent pedaling in the delayed reinforcement phase showed only 1 day that Participant 5 pedaled in her THRZ. Due to only 1 data point in this phase a celeration line was not able to be drawn. Therefore, no grade or slope for the celeration line could be calculated.

In Figure 10, there are 7 of the 8 days in the delayed reinforcement phase where Participant 5 did not pedal in her THRZ, giving her 0 minutes for those exercise bouts. Because of these 0s, data points did not show up on a Log_{10} graph. Four of the 0s along with the 1 data point did fall below the projected slope. Therefore, the binomial equation is calculated to determine the probability of obtaining all 8 data points below the slope, $({}^{8}{}_{8})\frac{1}{2}^{8}$, which is $(0.5)^{8} = 0.004$. Therefore, the null hypothesis can be rejected; the trend of pedaling in her THRZ in the contingent reinforcement phase is significantly different than the trend of pedaling in her THRZ in the delayed reinforcement phase. These results may be biased by the fact that Participant 5 did not pedal in her THRZ on 7 of the 8 days during the delayed reinforcement phase.

Participant 5 spent an average of 2.07 minutes/day pedaling in her THRZ during the contingent reinforcement phase (see Table 2). By contrast, Participant 5 spent an average of 0.03 minutes/day pedaling in her THRZ during the delayed reinforcement phase.

Participant 6

Participant 6 was a male who was 11 years and 4 months in age. The data trends by study phase are shown for Participant 6 in Figure 11. Participant 6 was randomly assigned to the contingent reinforcement phase first and delayed reinforcement phase

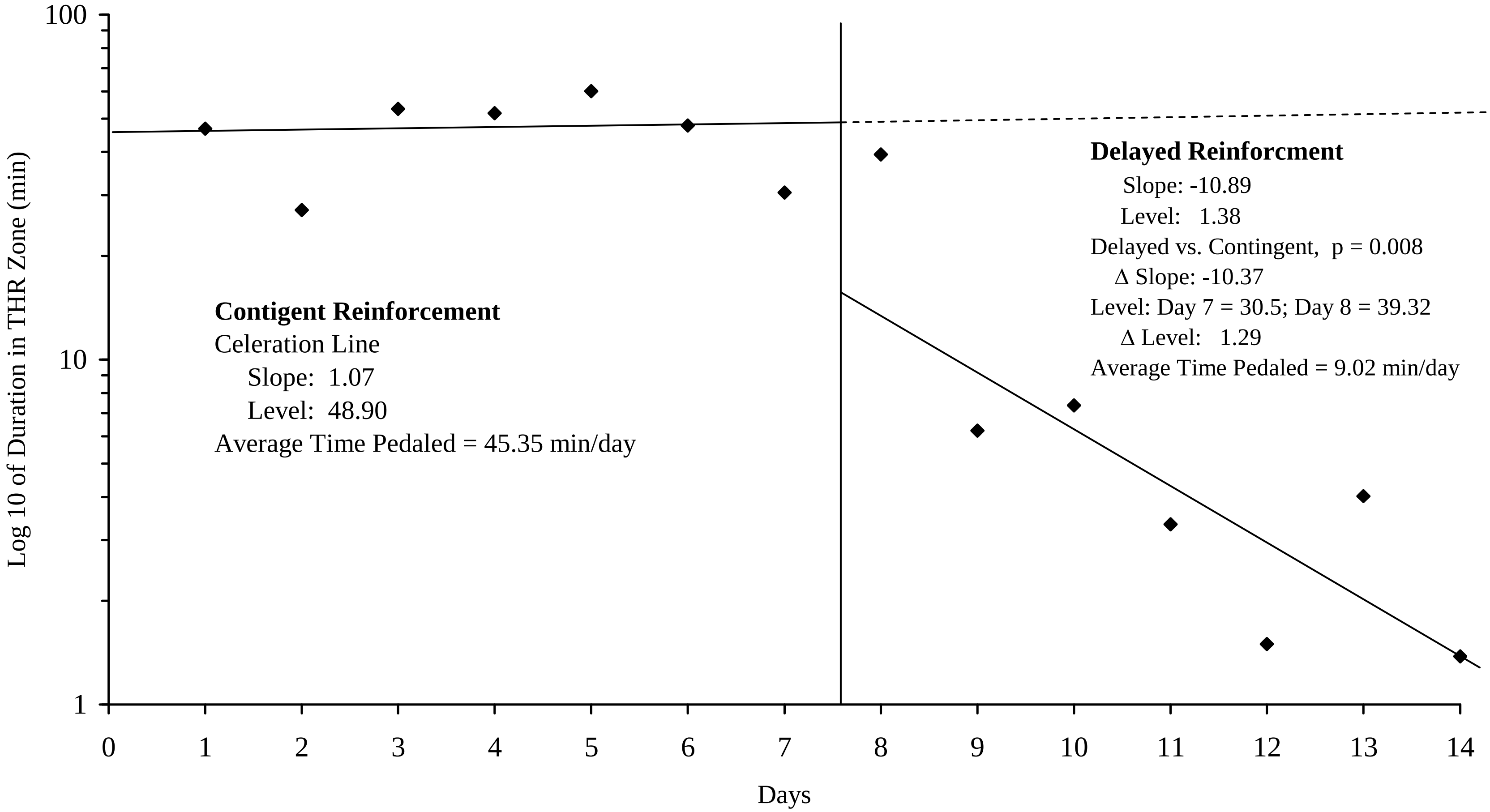

Figure 11: Participant 6 comparison between the contingent reinforcement phase and the delayed reinforcement phase with a significant (p = 0.008) difference between the two phases.

second.

During the contingent reinforcement phase, the slope of the celeration line was 1.07, signifying that the duration of pedaling on Day 7 was 1.07 times greater than on Day 1. Participant 6 increased his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 1 to Day 7

During the delayed reinforcement phase, the slope of the celeration line was -10.89, signifying that the duration of pedaling on Day 14 was 10.89 times lower than on Day 8. Participant 6 reduced his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 8 to Day 14.

There was a positive trend of pedaling in his THRZ during the contingent reinforcement phase and a negative trend of pedaling in their THRZ during the delayed reinforcement phase.

Comparing the delayed reinforcement phase to the contingent reinforcement phase, there was a change in slope between the two phases of -10.37and a change in level of 1.29. Therefore, the trend of pedaling for Participant 6 in his THRZ during the delayed reinforcement phase was 10.37 times less than during the contingent reinforcement phase. This signifies that there was a change across phases for the trend of pedaling in his THRZ.

In Figure 11, all 7 of the data points in the delayed reinforcement phase are below the projected slope from the contingent reinforcement phase. Therefore, the binomial equation is calculated to determine the probability of obtaining all 7 data points below the slope, $({}^{7}{}_{7})½^{7}$, which is $(.5)^{7} = 0.008$. Therefore, the null hypothesis can be rejected. The trend of pedaling in the THRZ during the contingent phase is significantly greater than the trend of pedaling in the THRZ during the delayed reinforcement phase.

Participant 6 spent an average of 45.35 minutes/day pedaling in his THRZ during the contingent reinforcement phase (see Table 2). By contrast, Participant 6 spent an average of 9.02 minutes/day pedaling in his THRZ during the delayed reinforcement phase.

Participant 7

Participant 7 was a female who was 7 years and 7 months in age. The data trends by study phase are shown for Participant 7 in Figure 12. Participant 7 was randomly assigned to the contingent reinforcement phase first and the delayed reinforcement phase second.

During the contingent reinforcement phase, the slope of the celeration line was 200.0, signifying that the duration of pedaling on Day 8 was 200 times higher than it was on Day 1. Participant 7 increased her time spent pedaling in her THRZ across the contingent reinforcement phase from Day 1 to Day 8.

During the delayed reinforcement phase, the slope of the celeration line was -11.67, signifying that the duration of pedaling on Day 16 was 11.67 times lower than on Day 9. Participant 7 reduced her time spent pedaling in THRZ across the delayed reinforcement phase from Day 9 to Day 16.

There was a positive trend of pedaling in her THRZ during the contingent reinforcement phase and a negative trend during the delayed reinforcement phase. Comparing the delayed reinforcement phase with the contingent reinforcement phase, there was a change in the slope between the two phases of -17.14. Therefore, the trend of pedaling for Participant 7 in her THRZ during the delayed reinforcement phase

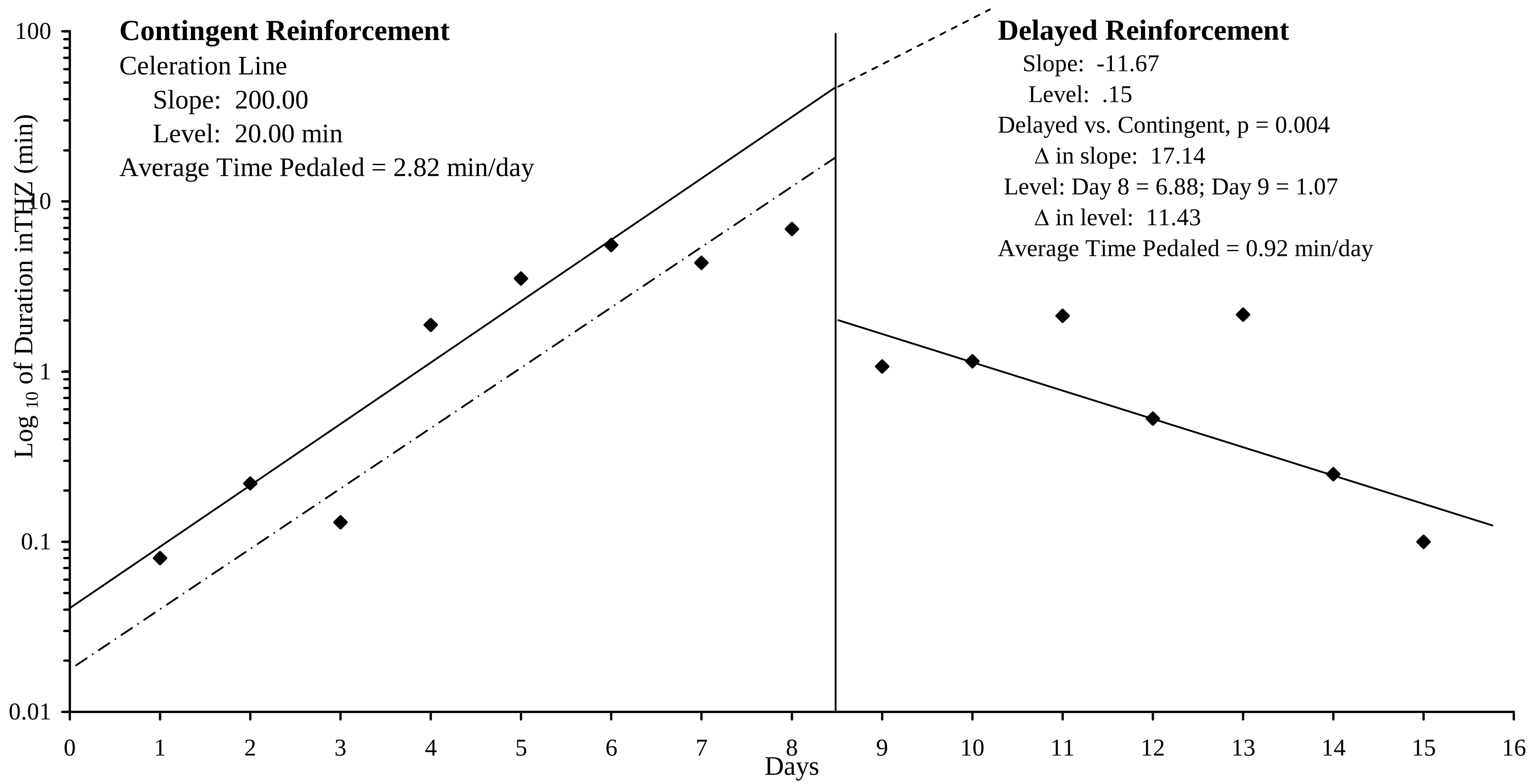

Figure 12: Participant 7 comparison between the contingent reinforcement phase and the delayed reinforcement phase with a significant (p = 0.004) difference between the two phases. The solid line in the contingent reinforcement phase is the adjusted celeration line and the broken line in the contingent reinforcement phase is the actual celeration line.

was 17.14 times lower than during the contingent reinforcement phase. This signifies that there was a change across phases for the trend of pedaling in her THRZ.

In Figure 12, all 8 of the data points in the delayed reinforcement phase are below the projected slope from the contingent reinforcement phase. Therefore, the binomial equation is calculated to determine the probability of obtaining all 7 data points below the slope, $({}^{8}{}_{8})½^{8}$, which is $(0.5)^8 = 0.004$. Therefore, the null hypothesis can be rejected. The trend of pedaling in her THRZ during the contingent reinforcement phase is significantly greater than the trend of pedaling in the THRZ during the delayed reinforcement phase.

Participant 7 spent an average of 2.82 minutes/day pedaling in her THRZ during the contingent reinforcement phase (see Table 2). By contrast, Participant 7 spent an average of 0.92 minutes/day pedaling in her THRZ during the delayed reinforcement phase.

Participant 8

Participant 8 was a male who was 6 years and 9 months in age. The data trends by study phase are shown for Participant 8 in Figure 13. Participant 8 was randomly assigned to the delayed reinforcement phase first and the contingent reinforcement phase second.

During the delayed reinforcement phase, the slope of the celeration line was -1.30, signifying that the duration of pedaling on Day 6 was 1.30 times lower than Day 1. Participant 8 reduced his time spent pedaling in his THRZ across the delayed reinforcement phase from Day1 to Day 6.

During the contingent reinforcement phase, the slope of the celeration line was

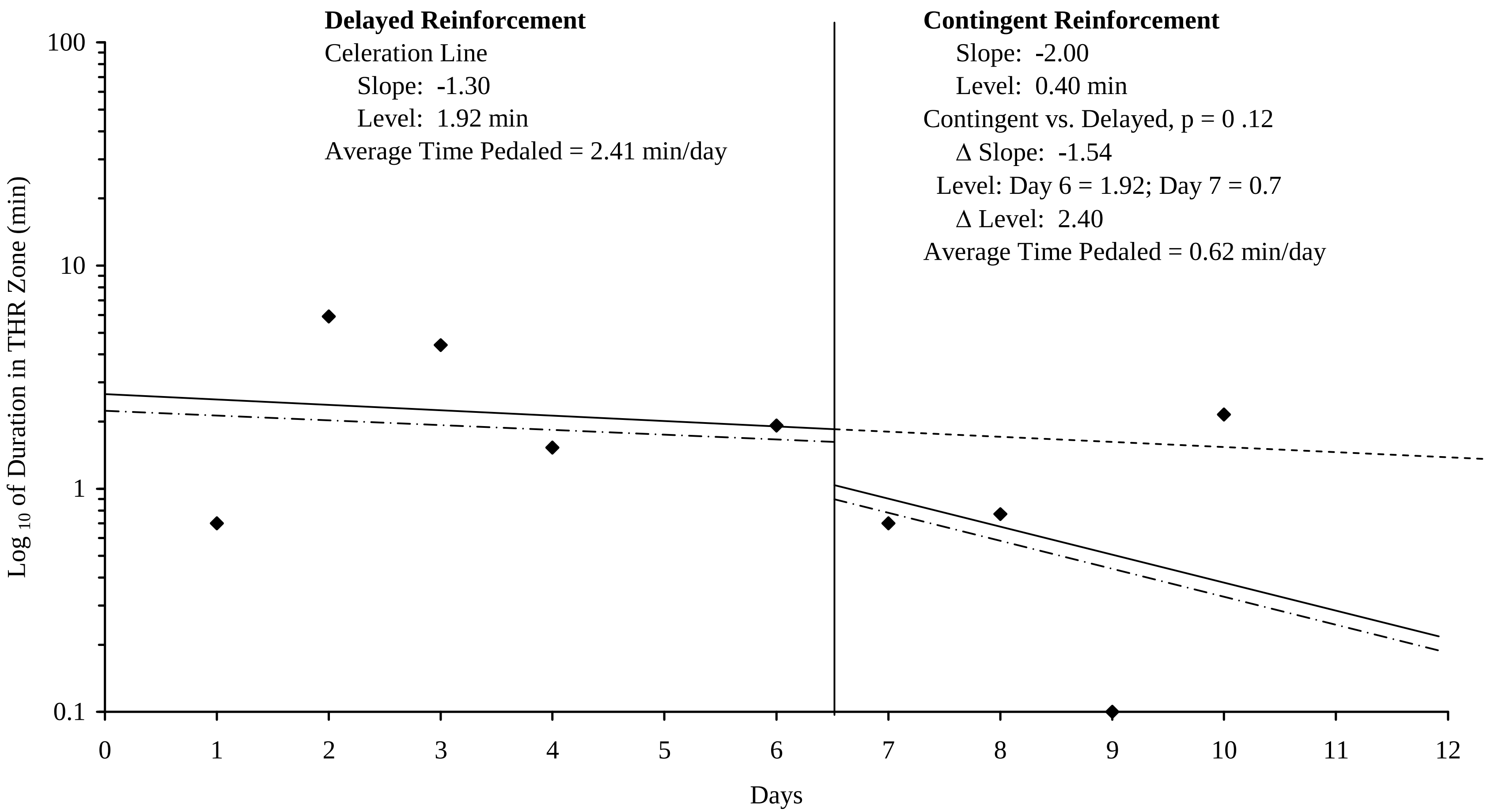

Figure 13: Participant 8 showed no significant difference between the two phases (*p* = 0.093) in total time pedaled in THRZ between the delayed reinforcement phase and the contingent reinforcement phase. The solid line in both phases is the adjusted celeration line and the broken line in both phases is the actual celeration line.

-2.00, signifying that the duration of pedaling on Day 12 was 2.00 times lower than on Day 7. Participant 8 reduced his time spent pedaling in his THRZ across the contingent reinforcement phase from Day 7 to Day 12.

There was a negative trend of pedaling in his THRZ during the delayed reinforcement phase and an even larger negative trend of pedaling in his THRZ during the contingent reinforcement phase.

Comparing the contingent reinforcement phase to the delayed reinforcement phase, there was a change in slope between the two phases of -1.54. Therefore, the trend of pedaling for Participant 8 in his THRZ during the delayed reinforcement phase was 1.54 times greater than during the contingent reinforcement phase for the slope and 2.40 times greater for level. This signifies that there was a change across phases for the trend of pedaling in his THRZ.

In Figure 13, 1 data point is above and 5 data points are below projected slope in the contingent reinforcement phase with 2 data points missing because Participant 8 failed to pedal hard enough to reach his THRZ on Days 5 and 6. Therefore, the binomial equation is calculated to determine the probability of obtaining all 6 data points above the slope, $({}^{6}{}_{1})½^{6}$, which is $(6)\ (.5)^{6} = 0.093$. Therefore, the null hypothesis cannot be rejected. The trend of pedaling in the THRZ during the contingent reinforcement phase is not significantly different than the trend of pedaling in the THRZ during the delayed reinforcement phase.

Participant 8 spent an average of 2.41 minutes/day pedaling in his THRZ during the delayed reinforcement phase (see Table 2). By contrast, Participant 8 spent an average of 0.62 minutes/day pedaling in his THRZ during the delayed reinforcement phase.

Participant 9

Participant 9 was a male who was 7 year 10 months in age. The data trends for Participant 9 are shown in Figure 14. Participant 9 was randomly assigned to the contingent reinforcement phase first and the delayed reinforcement phase second.

During the contingent reinforcement phase, the slope of the celeration line was 3.1, signifying that duration of pedaling on Day 5 was 3.1 times higher than on Day 1. Participant 9 increased his time spent pedaling in his THRZ across the contingent reinforcement phase from Day1 to Day 5.

During the delayed reinforcement phase, the slope of the celeration line was 223.68, signifying that the duration of pedaling on Day10 was 223.68 times higher than on Day 6. Participant 9 increased his time spent pedaling in his THRZ across the delayed reinforcement phase from Day 6 to Day 10. There is a positive trend of pedaling during the contingent reinforcement phase as well as an even more positive trend during the delayed reinforcement phase.

Comparing the delayed reinforcement phase to the contingent reinforcement phase, there was a change in slope between the two phases of 72. Therefore, the trend of pedaling for Participant 9 in his THRZ during the delayed reinforcement phase was 72.15 times greater than during the contingent reinforcement phase. This signifies that there was a change across the phases for the trend of pedaling in his THRZ.

In Figure 14, all 5 data points in the delayed reinforcement phase are below the projected slope from the contingent reinforcement phase. Therefore, the binomial

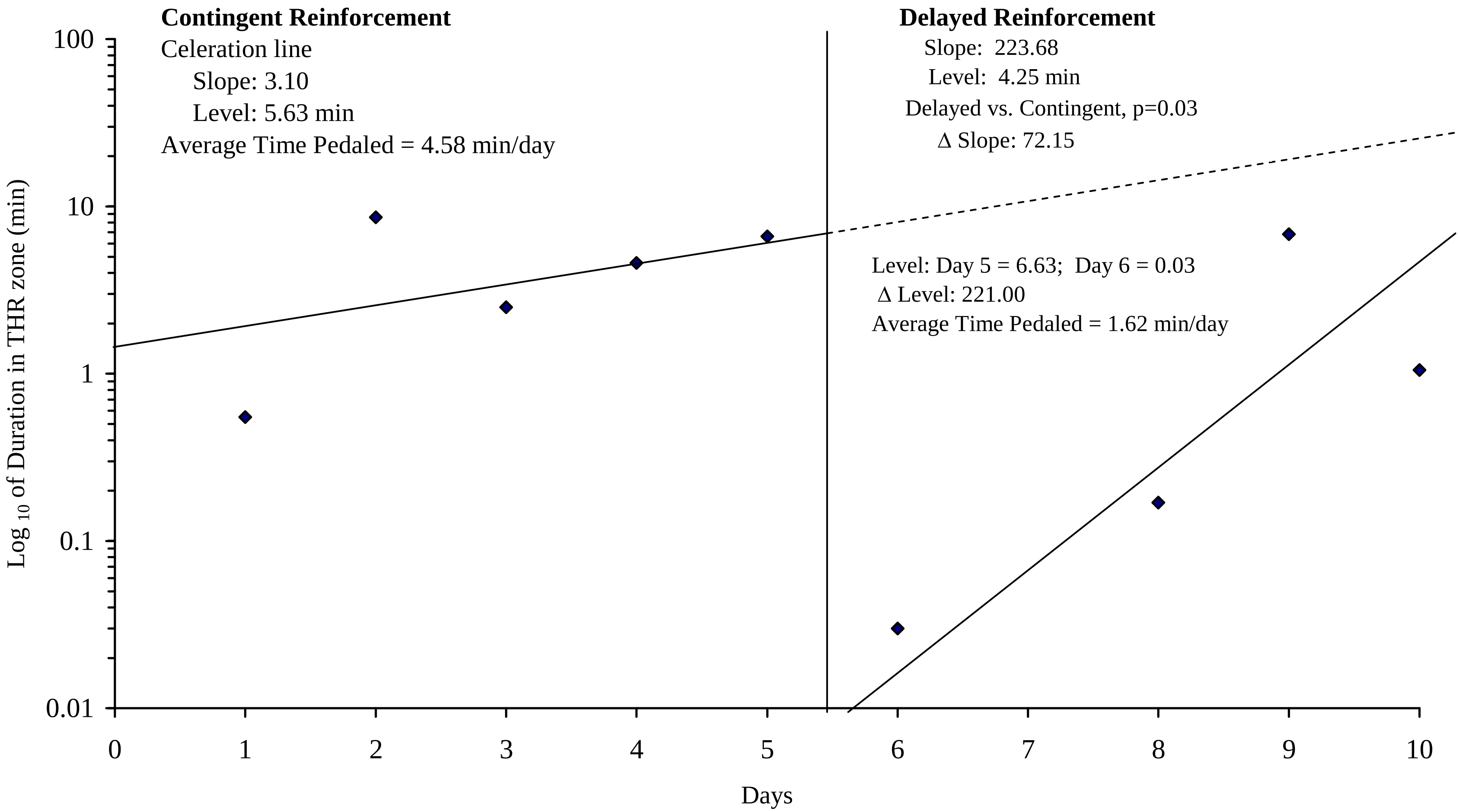

Figure 14: Participant 9 showed a significant difference between the two phases (p = 0.031) in total time pedaled in THRZ between the contingent reinforcement phase and delayed reinforcement phase.

equation is calculated to determine the probability of obtaining all 5 data points below the slope, $(^{5}_{5})\frac{1}{2}^{5}$, which is $(.5)^{5} = 0.031$. Therefore, the null hypothesis can be rejected. The trend of pedaling in the THRZ during the contingent reinforcement phase is significantly greater than the trend of pedaling the THRZ during the delayed reinforcement phase.

Participant 9 spent an average of 4.58 minutes/day pedaling in his THRZ during the contingent reinforcement phase (see Table 2). By contrast, Participant 9 spent an average of 1.62 minutes/day pedaling in his THRZ during the delayed reinforcement phase.

Discussion

Children who have autism have shown a trend similar to the general population with lower levels of physical activity that may lead to negative health factors (Curtin et al., 2005). The literature is limited on effective ways to motivate individuals with autism to increase physical activity. However, ABA has been effective in modifying other behaviors in children with autism such as improving bathroom skills, verbal skills, and decreasing maladaptive behaviors (Baer et al., 1987; Bregman et al., 2005; Dillenburger et al., 2004; Eikeseth et al., 2007; Harris & Delmolino, 2002; Jensen & Sinclair, 2002; Kroeger & Nelson, 2006; Mancil et al., 2006; Polirstok et al., 2003; Rousseau et al., 1994; Steege, Mace et al., 2007; Sulzer-Azaroff et al., 1991; Weeden & Poling, 2010).

Single subject designs allow researchers to generate detailed information about each individual participant and use feasible methods to look at trends within a subject and to determine how changes in those trends occurred both within a phase and across different phases (Horner et al., 2005). This design is particularly appropriate for participants who have autism because of the uniqueness of the characteristics of each child.

The findings in this study showed that there was a positive trend of pedaling in the THRZ in the contingent reinforcement phase for 6 out of the 9 participants. In addition, 7 of the 9 participants showed statistically higher slopes during the contingent reinforcement phase compared to the delayed reinforcement phase. This is similar to what was found in other populations in regards to the effectiveness of providing contingent reinforcement to achieve the target behavior (Luman et al., 2005; Mayhew et al., 1980; O'Reilly et al., 1994; Powell et al., 2002; Price et al., 2002). Specifically, contingent reinforcement was found to increase pedaling time on a cycle in populations that had intellectual disabilities (Caouette & Reid, 1985; Mathieson, 1991) and with children who were obese (Coleman et al., 1997; Faith et al., 2001).

Participant 1 showed a negative trend in pedaling in his THRZ in the first phase, which was the delayed reinforcement phase. When he entered into the contingent reinforcement phase, his level of pedaling increased substantially by increasing his average time pedaled per day in the contingent reinforcement phase nearly 4.7 times that of the average time he pedaled per day in the delayed reinforcement phase. The movie he picked to watch kept him engaged and motivated him to keep pedaling. Although pedaling during the contingent reinforcement phase also demonstrated a negative trend, the slope of the celeration line was much shallower than the during the delayed reinforcement phase.

It could be speculated that Participant 1 was more motivated to pedal in his THRZ by watching the DVD contingently than he was to pedal in his THRZ when he had to wait to watch the DVD until after he finished pedaling. This can be shown by the difference in average time pedaled. Participant 1's average time pedaled in his THRZ per day during the contingent reinforcement phase (13.81 minutes per day) was 4.7 times greater than his average time pedaled in his THRZ during the delayed reinforcement phase (2.92 minutes per day). Even though there was a negative trend during the contingent reinforcement phase it can be noted that he stayed motivated throughout the contingent reinforcement phase, as demonstrated by pedaling an average of 13.81 minutes per day and his times pedaled each day were fairly consistent compared to the delayed reinforcement phase.

Participant 2 also appeared to be more motivated to watch the DVD during the first phase, which was the contingent reinforcement phase. This is apparent by observing that there was a positive trend during the contingent reinforcement phase and a negative trend during the delayed reinforcement phase. Furthermore, his average time pedaled in his THRZ per day during the contingent reinforcement phase (5.94 minutes per day) was 1.7 times more than his average time pedaled in his THRZ during the delayed reinforcement phase (3.4 minutes per day). This indicates that he was motivated to watch the DVD he had selected when he could watch it while he pedaled but was less motivated to watch it when he had to wait until he was finished pedaling.

Participant 3 started off in the delayed reinforcement phase. There was a more linear grouping of data points during the delayed reinforcement phase with the exception of Days 1 and 7 that were considerably lower. This could be that on Day 1, Participant 3 may have had difficulty understanding the fact that pedaling in his THRZ would earn DVD viewing time. The slope of the celeration line during the contingent reinforcement phase was also positive and was steeper. This indicates a more positive trend than during the delayed reinforcement phase. This trend could possibly have increased if Participant 3 were allowed to continue pedaling over a longer period of time. It can be seen in Figure 8 that the slope of the celeration line in the contingent reinforcement phase would have surpassed the delayed reinforcement phase. Therefore, Participant 3 was possibly more motivated during the contingent reinforcement phase to watch the DVD because it was immediate over DVD viewing during the delayed reinforcement phase where the DVD viewing was delayed. His average time pedaled in his THRZ per day during the contingent reinforcement phase (21.74 minutes per day) was 2.35 times more than his average time pedaled in his THRZ during the delayed reinforcement phase (9.24 minutes per day).

Even though Participant 3 averaged more time per day pedaling in THRZ, he seemed more motivated during the contingent reinforcement phase than during the delayed reinforcement phase. However, there were only two data points in the contingent reinforcement phase that fell above the extended line from the delayed reinforcement phase and the change in slope from the two phases was not different.

There was a wide range in the time Participant 3 pedaled each day from 12 minutes to 59 minutes. The reason for the wide range in pedaling time is unclear. He selected the same DVD to watch each day. How he was feeling throughout the day as well activities that may have affected his mood were not recorded during the day. It is possible that outside events may have affected his motivation to ride. It is suggested that recording such events for each participant should be done in future research.

Participant 4 appeared to be less motivated to pedal during the delayed reinforcement phase in which he had to pedal first and watch the DVD later. His motivation to pedal did increase during the contingent reinforcement phase. The average time that Participant 4 pedaled in his THRZ during the contingent reinforcement phase was relatively small (1.6 minutes per day) but it was almost 5 times greater than during the delayed reinforcement phase (0.32 minutes per day). Perhaps the reason for the low rate of pedaling even in the contingent reinforcement phase was because he had difficulty staying focused. However, he was still able to show a significant change between the contingent reinforcement phase and the delayed reinforcement phase. Participant 4 (Figure 8) had a steep celeration line in the contingent reinforcement phase, thus indicating a steep positive trend during this phase when compared to the delayed reinforcement phase.

During the delayed reinforcement phase, there were times when this participant did not want to ride the bike and would get very upset. This lack of motivation to pedal could possibly be due to the fact that he did not like the movies that much. Perhaps he could have been motivated more by different types of reinforcement such as a video game that contingently turned on when pedaling in his THRZ. Further, maybe riding a bicycle was a mode of physical activity that he did not particularly like. Perhaps he would have been more likely to participate if a different mode of physical activity was required such as walking or if using interactive video games that require movement to be operated was the contingent reinforcement.

Participant 5 was somewhat erratic in her pedaling behavior during the first phase, which was the contingent reinforcement phase. She showed a decrease in the trend of pedaling in her THRZ across that phase. However, she did pedal in her THRZ for each day in the contingent reinforcement phase for an average of 2.07 minutes per day. She only reached her THRZ on 1 day of pedaling when she pedaled during the delayed reinforcement phase and that was for less than a minute.

It is speculated that Participant 5 was more motivated to pedal at the beginning because of the novelty effect. Over time, she became less intrigued with riding the cycle. And she was not motivated by DVD viewing to continue pedaling in her THRZ. She was not interested in pedaling at all in the second or delayed reinforcement phase.

Participant 6 was highly motivated to pedal in his THRZ during the contingent reinforcement phase. He had averaged just over 45 minutes per day of pedaling in his THRZ during the contingent reinforcement phase. This average was over 5 times that of the average time pedaled per day during the delayed reinforcement phase (9.02 minutes per day). His average time pedaled per day was the highest during the contingent reinforcement phase of all 9 participants. He really seemed to enjoy the DVD he selected as evidenced by the fact that he selected the same DVD every day. Therefore, this DVD was highly motivating to him.

Although he did not have a steep celeration line in the contingent reinforcement phase, he did show a positive trend when pedaling throughout this phase. He showed consistency throughout the contingent reinforcement phase, pedaling for a relatively long duration each day. When he changed phases and started the delayed reinforcement phase, he became extremely agitated during this phase when he had to wait to watch the DVD until after he finished pedaling.

Participant 6 clearly demonstrated a treatment order effect. He pedaled hard and for a fairly long time on the first day of the delayed reinforcement phase. Soon after, the time he pedaled in his THRZ dropped off sharply. It was speculated that on the first day of the delayed reinforcement phase, he thought he could still turn the television on and watch it contingently by pedaling just like he did during the contingent reinforcement phase. When this did not happen and he realized that the television would not turn on he became extremely agitated during the other testing days of this phase and did not want to pedal for very long at all.

Participant 7 started slowly at the beginning of the first phase, which was the contingent reinforcement phase. When she figured out that pedaling turned on the DVD, this increased her pedal duration for each day throughout this phase. This is indicated by a steep positive slope of the celeration line, signifying a sharp positive trend during this phase.

The average time that she pedaled per day in her THRZ during the contingent reinforcement phase (2.82 minutes per day) was 3 times greater than the average time that she pedaled during the delayed reinforcement phase (0.92 minutes per day). Since her time increased each day that she pedaled in her THRZ during the contingent phase could signify that she was motivated by television viewing during this phase. The DVD she had chosen and the fact that she could turn the television on to watch that DVD by pedaling harder could be a factor in motivating her to pedal for a longer period in her THRZ during this phase also.

She did not respond well to the delayed reinforcement phase, which is described by a sharp negative trend from Days 9 to 16. When she first started pedaling in the second phase, which was the delayed reinforcement phase, she probably thought that she could still turn the DVD on by pedaling. This was manifested by the fact that she pedaled fairly strong the first 5 days. However, when she figured out that she had to wait to view the DVD she had chosen, the time pedaled in her THRZ decreased during this phase. It is speculated that perhaps Participant 7 was more motivated to stop pedaling as soon as possible and watch the DVD immediately after pedaling on the final days of the delayed reinforcement phase. Her pedaling in her THRS decreased during the delayed reinforcement phase, thus resulting in a negative trend for this phase.

Participant 8 showed negative trends during both the delayed reinforcement phase and the contingent reinforcement phase with a larger negative trend during the contingent reinforcement phase. It was observed that his average time pedaled per day during the delayed reinforcement phase (2.41 minutes per day) was almost 4 times greater than during the contingent reinforcement phase (0.62 minutes per day) resulting in an unexpected outcome.

It appeared that throughout both phases of exercise testing he did not seem to be motivated at all by the DVDs that he picked nor by the television viewing. This participant appeared to get extremely bored as the study progressed. When the television would come on, he did not appear interested in watching it, even though he had selected the DVD to watch. It is possible that riding a bicycle was not something that he enjoyed even if he could watch a DVD while pedaling. Another speculation is that riding a bicycle may not have been the mode of exercise that was enjoyable to him. Whereas other participants seemed excited to ride a stationary recumbent cycle, he did not seem to show that same emotion. It could be concluded that from the observations during the exercise sessions, he was not motivated by any of the DVDs, the opportunity to ride a bicycle, nor television viewing when compared to the other participants.

Participant 9 showed a positive trend during both the contingent reinforcement phase and the delayed reinforcement phases. There was a stronger trend being reported during the second phase, or delayed reinforcement phase. Even with a stronger trend displayed during delayed reinforcement, Participant 9 averaged almost 3 times the average time pedaled per day during the contingent reinforcement phase (4.58 minutes per day) compared to the delayed reinforcement phase (1.62 minutes per day). He was somewhat motivated by watching the DVDs that were available for viewing.

He had fewer days that he participated during the study due to the fact that he entered the study late. Therefore, he had only 5 days of testing during each phase. Having fewer days of observation could have had an impact on the trends in both phases. It is possible that the trend of pedaling in his THRZ would have increased more during the contingent reinforcement phase than during the delayed reinforcement phase over the course of the study by having more days of testing during each phase.

The increased prevalence of a positive trend during contingent reinforcement supports the previous literature that an ABA style approach is successful in changing behaviors in this population similar to changing behaviors to improve toilet training, increase verbal expression, and decrease unwanted behaviors (Baer et al., 1987; Bregman et al., 2005; Dillenburger et al., 2004; Eikeseth et al., 2007; Harris & Delmolino, 2002; Jensen & Sinclair, 2002; Kroeger & Nelson, 2006; Mancil et al., 2006; Polirstok et al., 2003; Rousseau et al., 1994; Steege et al., 2007; Sulzer-Azaroff et al., 1991).

Other studies in the literature show similar results using contingent reinforcement, Faith et al. (2001) looked at how contingent reinforcement increased pedaling duration in children who were obese. Two other studies, Caouette and Reid (1985) and Mathieson (1991), found that contingent reinforcement increased pedal duration in adults with intellectual disabilities.

The findings in this study show a trend across participants that support the hypothesis that a contingent reinforcement intervention is more effective than the delayed reinforcement intervention in increasing pedaling duration on a stationary recumbent cycle in THRZ in children with autism. However, 2 of the participants did not seem to respond to either type of reinforcement with a positive trend and only 3 were physically active enough to derive any type of health benefit. According to the CDC, that is 60 minutes of moderate to vigorous activity most days of the week (CDC, 2010).

One of the strengths of using heart rate monitors was that researchers were able set THRZ based on each individual participant's resting heart rate. In addition, work load could be controlled so the participants would push themselves to get into and stay in their THRZ.

The other research studies in the literature on children with autism and physical activity have only used two modes of exercise, walking or jogging, and the researchers primarily examined the effects that physical activity had on classroom behaviors such as self-stimulation or getting out of their chair. Only one study in the literature examined a technique to motivate individuals with autism to be more physically active. Todd and Reid (2006) observed 3 young men diagnosed with autism over a 6-month outdoor recreation program. This program consisted of walking/jogging and snowshoeing. They used a self-monitoring board where the participants placed a smiley sticker on a board when they completed a circuit. They also used edible reinforcers as well as verbal cueing to motivate the children. They were able to determine that these interventions did increase physical activity. This research study examined a different mode of physical activity, a stationary recumbent cycle, and a different type of reinforcer, contingent and delayed television viewing. Both studies showed significant increases in physical activity.

The results of this study could provide practitioners and researchers with another mode of physical activity and a way to motivate individuals with autism to be physically active. Parents could also use these techniques to help motivate their children to be physically active at home. Furthermore, teaching children with autism to ride a bike is an important skill for them to acquire not only to be physically active, but to integrate with other family members and with children in the community.

Not all factors in this study could be controlled so there may have been intervening variables that affected the motivation to pedal the cycle. For example, there may have been experiences throughout the day, such as change in activities, that may have made the participant agitated or angered. This may have affected the mood or the behavior of the child that were not observed and possibly had an effect on the outcome. Furthermore fatigue, diet, and social interaction conditions were not recorded. Any change or deviation from the norm for each participant could have had an effect on the outcome. Exercise habits of the child and their families were not recorded either. Therefore, it is somewhat difficult to establish with certainty which factors attributed to pedaling behaviors.

There were limitations in this study that may have affected the results. Using a small sample size made overall generalizations about this population limited to those students at the Carmen B. Pingree Center for Children with Autism. However, by comparison, this study had more participants (n = 9) than all the other research studies in the literature review by Lang et al. (2010). Along with small sample size, the data set of days pedaled in each phase was small. This could be the reason that some of the results were not found to be statistically significant. It should be noted though that the split-middle technique is more concerned with trends and the changes in trends rather than statistical significance. Increasing the number of treatment days in each phase perhaps would have provided a better indication of pedal duration trends in this population.

Furthermore, this sample was a biased sample because the participants were selected by their classroom teachers. There was no randomization of who participated in this study due to a limited population that met the inclusion criteria. The participants who were in the study needed to have higher social, cognitive, and language abilities than other students at the Center so they could participate and understand the concepts. Having a biased sample minimizes the ability to generalize the results to other students who are diagnosed with autism.

Another limitation in this research study was the use of HRR for this population to determine each participant's THRZ. Oxygen consumption (VO_2) and HR are important indicators of exercise intensity to improve cardiorespiratory fitness. The relationship of oxygen consumption and heart rate testing in adults to improve their fitness levels has been well documented in the research. However, there has been limited research conducted for children and adolescents in this area (Hui & Chan, 2006). Using HRR to calculate exercise intensities may cause some discrepancies in that the children are physiologically different than adults. For example, children typically have higher heart rates during rest and exercise compared to adults (Cheatham, Mahon, Brown, & Bolster, 2000). This may raise some questions in that the exercise intensities may be different than adults. Even though HRR has been used by some researchers to establish THRZs for children during participation in physical activity, the age predicted maximal heart rate (HRmax) calculation of the HRR method may not be accurate in children (Hui & Chan, 2006). Therefore, this formula needs to be further researched in children and adolescents to determine a more accurate calculation when determining exercise intensities for this population.

With an increase in the number of children being diagnosed with autism (CDC, 2007) and more and more children being mainstreamed into the public schools (U. S. Department of Education, 2007) educators are continually searching for methods to provide an appropriate education for this population. This includes physical education. The use of contingent reinforcement may serve as an effective technique to motivate children with autism to become and stay physically active during physical education class. When used outside of school, this technique may even help individuals with autism be more active throughout their lives.

Because children with autism often exhibit inappropriate behaviors in group settings, they may either be on the side and not participating in activities or be back in the classroom during physical education. One solution to this problem might be to have these children with autism ride a stationary bicycle and they would be participating in physical activity without disrupting the other students in the class.

Parents who have children with autism could use contingent reinforcement to motivate their child to be more physically active. This might free up the parent’s time to do other things while the child is exercising. In addition, contingent reinforcement puts the reward system in the child’s hands giving them more responsibility over their physical activity behavior.

CHAPTER 5

SUMMARY, FINDINGS, CONCLUSION, AND RECOMMENDATIONS FOR FUTURE RESEARCH

Summary

The primary purpose of this research was to determine if there were differences in the way reinforcement was administered to motivate children with autism to pedal longer in their THRZ. Two types of reinforcement were utilized in the form of delayed reinforcement and contingent reinforcement. It was hypothesized that contingent reinforcement would provide a better result in motivating children with autism to pedal in their THRZ than delayed reinforcement. Participants were asked to pedal during the two conditions. Children that pedaled in the delayed reinforcement phase were not allowed to watch television until they finished pedaling while during the contingent reinforcement phase, if they reached their THRZ, the television would turn on immediately and stay on if they continued to pedal in their THRZ. Times were recorded and trends from both conditions were analyzed and compared.

In general, participants pedaled longer and had positive slopes in the contingent reinforcement phase of the study and negative trends during the delayed reinforcement phase. However, these trends were not consistent in all 9 participants and many variations occurred in the data. For instance, Participant 3 as well as Participant 9 showed a positive trend in pedaling during both the contingent reinforcement and delayed reinforcement phases. Participants 2, 4, 6, and 7 showed positive trends during the contingent reinforcement phases with negative trends during the delayed reinforcement phases. Participants 1, 5, and 8 had negative trends for both the contingent reinforcement and delayed reinforcement phases.

Participants 1, 3, and 6 were the 3 most highly motivated during the continent reinforcement phase. In addition Participant 6’s average time pedaled per day during the contingent reinforcement phase indicated that he was close to meeting the guidelines set forth by the CDC which are that children and adolescents ages 6-17 should be engaging in moderate to vigorous physical activity 60 minutes per day (CDC, 2010 b). The other participants were not as close to meeting those guidelines.

Participants 1, 5, and 8 had declines in the slope of the celeration lines in the contingent reinforcement phases. Because this was a new activity in their daily routine, it is possible that there was a novelty effect. The differences between the contingent reinforcement phase and the delayed reinforcement phase were significant for Participants 1 and 5. Participant 8 showed an even stronger negative trend during the contingent reinforcement than he did during the delayed reinforcement phase. DVD viewing did not seem to be motivating for this participant.

Six of the 9 participants (Participants 2, 3, 4, 6, 7, and 9) showed a positive trend of pedaling in their THRZ during the contingent reinforcement phase. In contrast, only 2 of the 9 participants (3 and 9) showed a positive trend of pedaling in their THRZ when they were exposed to delayed reinforcement. During the delayed reinforcement phase, there were sharp negative trends with Participants 1, 2, 4, 6, 7, and 8. Participant 8 showed the least amount of progress during the contingent reinforcement phase. It could be that Participant 8 did not seem to be motivated by watching DVDs.

Participants 3 and 8 were the only 2 to show no difference in slopes between the phases. Both started with the delayed reinforcement phase but Participant 3 showed positive slope in both phases and Participant 8 showed negative slopes.

In this study, it appeared that 3 of the participants (4, 5, and 8) were not as motivated by DVD viewing compared to the other participants. Participant 7 did not seem motivated at the beginning of the contingent reinforcement phase. However, that seemed to change as the phase continued. She pedaled longer towards the final days of that phase creating a steep trend line. Perhaps future research should employ more direct methods to select a reinforcer (different DVD) similar to those methods mentioned in the article by Weeden and Poling (2010) such as allowing the participant to interact with different reinforcers. Data would then be collected and the reinforcer that the participant used more frequently or for a longer period of time would be selected to be used to motivate the participant throughout the study.

Determination of the strength and direction of a trend is the primary objective when calculating the split-middle technique (Barlow & Hersden, 1984; Kazdin, 1982). However, statistical significance of the trends for each phase as well as the change in trends across the two phases can be calculated. Seven of the participant's data were found to be statistically significant. Data for Participants 1, 5, 6, and 7 were found to be statistically significant below the 0.01 level, whereas data for Participant 2, 4, and 9 were found statistically significant below the 0.05 level. Participants 3 and 8 showed no statistical significant difference in the slopes across phases.

The duration of pedaling in the THRZ decreased across the phase for delayed reinforcement for each participant except Participants 3 and 9 who showed a positive trend. The opposite was found for the contingent reinforcement phase in which 6 of the 9 participants showed a positive trend.

By examining the data in Table 2, it was determined that contingent reinforcement was more effective in motivating children to pedal longer in their THRZ than delayed reinforcement. The average time pedaled was higher for all participants in the contingent reinforcement phase compared to the delayed reinforcement phase, except for Participant 8 who actually decreased his average time pedaled from 2.41 minutes/day in the delayed reinforcement phase to 0.62 minutes/day in the contingent reinforcement phase. It is noted that there was considerable variation across participants in regards to the average time pedaled. Even though 8 of the 9 participants demonstrated a greater average for the amount of time they pedaled during the contingent reinforcement phase compared to the delayed reinforcement phase only 3 pedaled long enough to possible see some type of health benefit according to the CDC's guidelines (2010 b).

Participant 6 had the greatest difference in average minutes/day pedaled from 9.02 minutes/day during the delayed reinforcement phase to 45.35 minutes/day during the contingent reinforcement phase. Participant 2 had the smallest average increase from 3.36 minutes/day in the delayed reinforcement phase to 5.94 minutes/day in the contingent reinforcement phase. When looking at the average time ratio, there was a 1.77 to 5.03 times increase from delayed reinforcement to contingent reinforcement in terms of average minutes/day of pedaling time in the THRZ.

Participant 5 had an average time pedaled in her THRZ for the contingent reinforcement phase that was 66.37 times that of the delayed reinforcement phase. In the delayed reinforcement phase, there was only one time that she entered her THRZ. The remaining exercise sessions, she did not pedal hard enough to reach her THRZ. This could be due to the fact that she wanted to watch the DVDs immediately. She was not interested in pedaling for a long time before she could watch television.

Although there was a great deal of variability in the data, it appears that contingent reinforcement can be a valuable tool for getting some individuals with autism to increase the time they can pedal in their THRZ.

Findings

There are three main findings that can be extracted from this research study:

1. First, in can be mentioned that contingent reinforcement was more effective than delayed reinforcement in increasing pedaling duration in the THRZ of children with autism.
2. Second, the physical activity levels of the children with autism were variable. Some of the participants pedaled in their THRZ for less than 3 minutes in each reinforcement condition while others pedaled considerably longer.
3. Two of the children with autism showed no difference in the slope of pedaling in the THRZ for contingent and delayed reinforcement conditions.

Conclusions

From the findings the following conclusions can be made about contingent and delayed reinforcement:

1. Contingent reinforcement was more effective than delayed reinforcement in increasing physical activity.
2. Recumbent cycling offers a mode of exercising that may be beneficial, safe, and enjoyable for children with autism.
3. Although watching DVDs contingent on achieving a training heart rate zone may be an effective way to get some children with autism to exercise, it may not be appropriate for all children.

Recommendations for Future Research

Future research based on the results of this study needs to be conducted. A larger sample size could be used in order to generalize the results to other populations. A more varied population with autism spectrum disorders such as children who have been diagnosed with more severe autism could be included, thus providing more information about ways to increase physical activity levels with children who have more severe autism. As a secondary benefit, these children could learn the actual pedaling skill and possibly be able to participate in bicycle rides with family and peers.

More days of observations would be advantageous to determine if pedaling trends can be maintained over a longer period of time. Other modes of exercise such as jogging, walking, jumping on a trampoline, doing jumping jacks, swimming, snowshoeing, etc. could be examined to see if contingent reinforcement will increase the time an individual with autism is physically active.

With the random order of the treatments, 4 participants pedaled in the delayed reinforcement phase first and the contingent reinforcement phase second. Two of the 4 (50%) had expected results when assigned this order. Five participated in the contingent reinforcement phase first and the delayed reinforcement phase second and 5 out of the 5 (100 %) showed the expected results when assigned to this order. These results could be the result of a possible order affect in that outcomes were determined by which treatment they received first and which one they received second. It is recommended that more research be done in this area to minimize any effects that may be apparent due to the order of the treatment.

Future research may examine the physical activity levels, skill levels, and nutritional habits of the participants to determine if these factors have an effect on their participation in a fitness activity.

APPENDIX A

OBSERVATION FORM FROM PILOT STUDY FOR CLASSROOM BEHAVIOR

Child Observed: ____________ Evaluator: __________________

Date of Videotaping: _______ Total Time of Videotaping:______________

Location of Activity _____________________ Pre Exercise __ Post Exercise__

Activities during Videotaping: _______________________

Observed Behaviors: ______________________

____

____

Instructions:

1) For each minute of observation, mark the type of activity the child is engaged in i.e., Individual Work (IW), Group Work (GW) by putting an "X" in the appropriate column for the activity.
2) If that activity, i.e., Individual Work continues, draw a line vertically through the boxes until the activity changes then put an "X" in same column indicating the activity has stopped. Then put an "X" in the column for the new activity, i.e., Group Work.
3) Individual Work is working one on one with teacher or working individually on a project; Group Work is working in a group of two or more while working with a teacher.
4) When the child exhibits and "Off Task Motor Behavior" such as self-stimulatory behaviors (hand flapping, rocking the body) standing up and walking around the room, etc., put an "M" in the box corresponding to the appropriate time when the behavior begins.
5) Draw a line horizontally through the boxes as the behavior continues until the behavior stops then put an "M" in the box signifying the "Off Task Motor Behavior" has stopped.
6) When the child exhibits an "Off Task Passive Behavior" such as looking away from the teacher or object of the lesson, closing his eyes, leaning his head on the table, etc. put a "P" in the box corresponding to the appropriate time when the behavior begins.
7) Draw a line horizontally through the boxes as the behavior continues until the behavior stops then put a "P" in the box signifying the "Off Task Passive Behavior" has stopped.

Total Time in Each Activity:

IW: ____ GW: ____ Other: _____

Off Task Motor ____ Off Task Passive ____

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IW-Independent Work **GW**-Group Work **O**-Other **TT**- Total Time **P =Off**-Task Passive **M=**-Off Task Motor Totals

APPENDIX B

PARENTAL PERMISSION FORM

Parental Permission Document

BACKGROUND:
Your child is being invited to take part in a research study by a doctoral student from the University of Utah for a final dissertation. Before you decide whether to allow your child to participate it is important for you to understand why the research is being conducted and what will be involved. Please take time to read the following information carefully in order to decide whether or not you will allow your child to take part in this study. Feel free to ask questions if there is anything that is not clear or if you would like more information.

Childhood obesity has become an increasing trend. The risks that accompany obesity can also be increased as children age. Physical activity in the form of riding a bicycle may help to decrease the risks associated with inactivity. Riding a bicycle can be a fun and enjoyable form of activity in which to participate. This research study is an attempt to discover ways to help children with autism become more physically active by using a bicycle.

STUDY PROCEDURE:
During this study, your child will visit with me along with personnel that are trained to work with children with autism on a daily basis for the duration of three weeks. The length of each meeting time will be between 10 to 30 minutes. Your child, with your permission, will be videotaped for observation while in the classroom before and after each exercise session, and they will be videotaped during each exercise session. During the first week of the study your child will be asked to ride a stationary bicycle for as long and hard as he/she wants. During the second week, your child will ride the stationary bicycle again. However, this time he/she will be rewarded by watching television when he/she finishes riding the bicycle. During the third and final week, your child will ride the bicycle again but this time when his/her heart rate reaches the exercise zone, he/she will be rewarded immediately by the television turning on while pedaling. There will be between 5 and 15 other children participating in the research study.

Furthermore, to better clarify and present these research results, information from your child's school performance would need to be analyzed, therefore, the learning accomplishment profile (LAP) of each child will be used to better understand student performance and classroom activity. Additionally, your child's official diagnosis, if provided on the line below, will help explain the population that participated. This information will be used only for this research study.

Official diagnosis of your child:____

RISKS:
The risks of this study are minimal. The children may feel some discomfort in joints if pedaling a bicycle for a period of time is new to them. Furthermore, some mild discomfort may be experienced from the heart rate monitor strap placed around the mid

chest, rib, and back area. There may be discomfort felt in sitting for a prolonged period of time. Please list any health conditions such as heart problems, asthma, etc. that may put your child at risk in this study below. If there is any medical condition that could negatively impact your child they may be excluded from the study.

____

BENEFITS:
We cannot promise any direct benefit to your child as the result of taking part in this study. However, possible general benefits include providing a new perspective on bicycle riding as fun and enjoyable, and as effective to promote physical activity. We also hope that the information we obtain from this study will help us gain a deeper understanding of how to promote physical activity among children with autism and to discover the benefits to them of being more physically active.

ALTERNATIVE PROCEDURES:
Your child does not have to take part in this study. Your child may change his/her mind later on in the study if he/she wants to stop participating.

VOLUNTARY PARTICIPATION:
It is up to you to decide whether to allow your child to take part in this study. Refusal to allow your child to participate, or the decision later on to withdraw your child from this research, will involve no penalty or loss of benefits to which your child is otherwise entitled, and will not affect you or your child's relationship with the school.

CONFIDENTIALITY:
Your child's records concerning this research study will be stored in a locked filing cabinet or on a password-protected computer located in the researcher's office (HPER W 101). Only the researcher and members of his study team will have access to this information. A number will identify your child during the study so his/her real name will not be in any of the records. The data will be kept confidential. All video recordings will be erased or destroyed immediately after data has been collected, during spring semester of 2009, but no later than July 2009.

PERSON TO CONTACT:
If you have questions, complaints or concerns about this study, you may contact David Anderson at (801) 581-7964. If you feel your child has been harmed as a result of participation, please call Hester Henderson, who may be reached during the hours of 8-5pm Mondays through Fridays, at (801) 581-7964.

INSTITUTIONAL REVIEW BOARD:
You may contact the Institutional Review Board (IRB) if you have questions regarding your child's rights as a research participant. Also, you may contact the IRB if you have questions, complaints or concerns that you do not feel you can discuss with the investigator. The University of Utah IRB may be reached by phone at (801) 581-3655 or by e-mail at irb@hsc.utah.edu. You may also contact Gary Franchina, at:

Gary Franchina, Chair
Institutional Review Board
Utah Department of Human Services

120 North 200 West, Room #221
Salt Lake City, Ut 84103-1550
(801) 538-4109

Utah law requires researchers to report any suspected or actual abuse, neglect, or exploitation of a child, an adult 65 or older, or an adult who has a mental or physical impairment that affects that person's ability to provide for or protect him/herself. If one has reason to believe that such abuse, neglect, or exploitation has occurred, he/she must report this to Child Protective Services (CPS), Adult Protective Services (APS), or the nearest law enforcement agency.

The preceding statement means that if there is any actual or suspected abuse, neglect, or exploitation of a certain individual that is unable to protect him/herself due to age or physical or mental impairments it is required by state law to report this to Child Protective Services (CPS), Adult Protective Services (APS), or the nearest police station.

COSTS AND COMPENSATION TO PARTICIPANTS:
There are no costs to participate in this study. Your child will receive a DVD of his/her choosing from a selection at the end of the study.

CONSENT:
By signing this consent form, I confirm I have read the information in this parental permission form and have had the opportunity to ask questions. I will be given a signed copy of this parental permission form. I voluntarily agree to allow my child to take part in this study. Also, I agree to provide additional information from my child's Learning Accomplishment Profile (LAP).

____
Child's Name

____
Parent/Guardian's Name

__________________________ _____________
Parent/Guardian's Signature Date

____
Relationship to Child

____
Name of Researcher or Staff

__________________________ _____________
Signature of Researcher or Staff Date

__________________________ _____________
Signature for Permission of Videotaping Date

APPENDIX C

ASSENT FORM TO PARTICIPATE IN THE STUDY

Assent to Participate in a Study

Purpose of the Research

I understand that there are researchers at the University of Utah that are studying how children can exercise more by riding a bicycle. I also understand that the researchers want to know how riding a bicycle will change my schoolwork in the classroom. They want me to ride a bicycle to see how long I will pedal. My parents and I have agreed to help.

Procedure/Intervention/Method

I will ride a bicycle while watching television at different times during exercise. I can pedal as long as I want and will choose and keep a DVD from a selection of movies that the researchers have.

I am aware that University of Utah researchers will videotape me in my classroom for 30 minutes. They will want me to come to the exercise room with a teacher or teacher aid from my classroom and ride a bicycle that is not moving. I will watch my favorite DVD movie at different times to see if it helps me to ride a bicycle longer and harder. The researchers will videotape me again after I exercise. I will do this every day for three weeks. I will also wear a strap around my chest that will tell me how fast my heart is beating.

Risks

I understand that I my legs may get tired when I am pedaling. The strap that I am wearing to measure my heartbeats may also be uncomfortable. I understand that I can stop pedaling at anytime.

Benefits

By your agreeing to be in this study, we can better understand how to make physical activity fun. You may learn that you like to be physically active, and the study can help others to discover which physical activity is fun for them as well.

Alternative Procedures and Voluntary Participation

I understand that I don’t have to do any part of this study. I can stop doing the study at any time. If I have any questions, I can call Dr. Hester L. Henderson at (801) 581-7964 or David Anderson at the same phone number. I can also contact:

Gary Franchina, Chair
Institutional Review Board
Utah Department of Human Services
120 North 200 West, Room #221
Salt Lake City, UT 84103-1550, (801) 538-4109

I know that Utah has a law that Hester Henderson, David Anderson or anyone else must tell the police and people that work at Child Protective Services and Adult Protective Services if I feel that I may get hurt or I am neglected. They will do this so I can be protected.

Confidentiality

The researchers at the University of Utah will help not to tell anything that I don't want shared with other people. I understand that videotapes will be destroyed when the study is over. They will be destroyed by this summer. I also understand that my name will not be used and they will give me a number.

Consent

If I sign my name at the bottom I can ride a bicycle in this study and watch a DVD. I will also be videotaped. The researchers will give my parents and me a copy of this paper to take home

Compensation

I understand that when I am done with this study I will get to pick and keep my favorite movie from other movies.

____
Printed Name of Child

____ _______________________
Signature of Child Date

____
Printed Name of Witness

____ _______________________
Signature of Witness Date

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